SCIENTIFIC AMERICAN SUPPLEMENT No 351

Scientific American Supplement. Vol. XIV., No. 351.
Scientific American, established 1845.

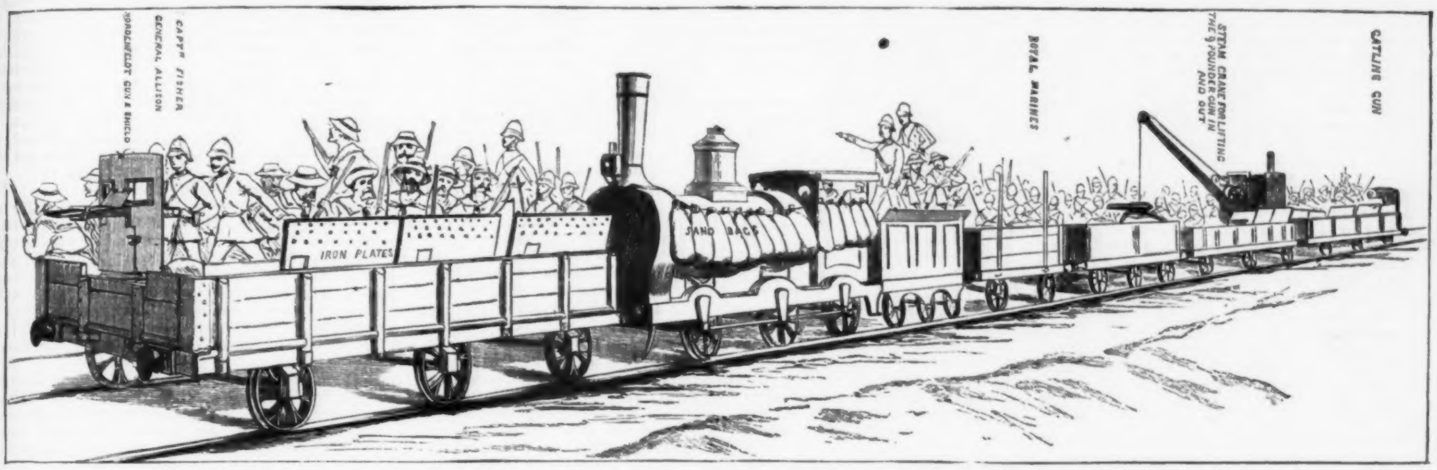
NEW YORK, SEPTEMBER 23, 1882.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE WAR IN EGYPT.

THE "naval armored railway train" is the subject of two of our illustrations, being a complete novelty in military practice, at least in Europe; though it is said that there was something like it in the American civil war. This locomotive fortress consists of six trucks protected with iron shields, the engine being in the center. A Nordenfeldt gun looks over the bows of the leading truck, and three Gatlings over the stern of the hindmost. The men in the trucks are protected from musketry by a row of sandbags. Two field guns are carried in one of the other trucks or wagons, built for heavy weights; but it is intended to place a seventon gun in this wagon. The train is manned by two companies of the Alexandra blue-jackets and one company of those of the Inflexible, to work the guns, under the command of Commander Hammill, having under him Lieutenants Hamilton, Bailey, and Younghusband. Captain Fisher, of H. M. S. Inflexible, assisted by Lieutenant Poore, contrived the whole affair, and superintended its construction and equipment, afterward directing its movements, with two hundred picked men to form the proper crew. The train is provided with mines, electric gear, and all appliances for laying down or destroying rails. It is also furnished with a powerful steam-crane for shifting guns and other heavy articles.

An empty wagon goes before the train, and can be shunted forward, the train stopping, from time to time, to try whether the line is clear, and to explode any mines that may have been laid beneath the rails.



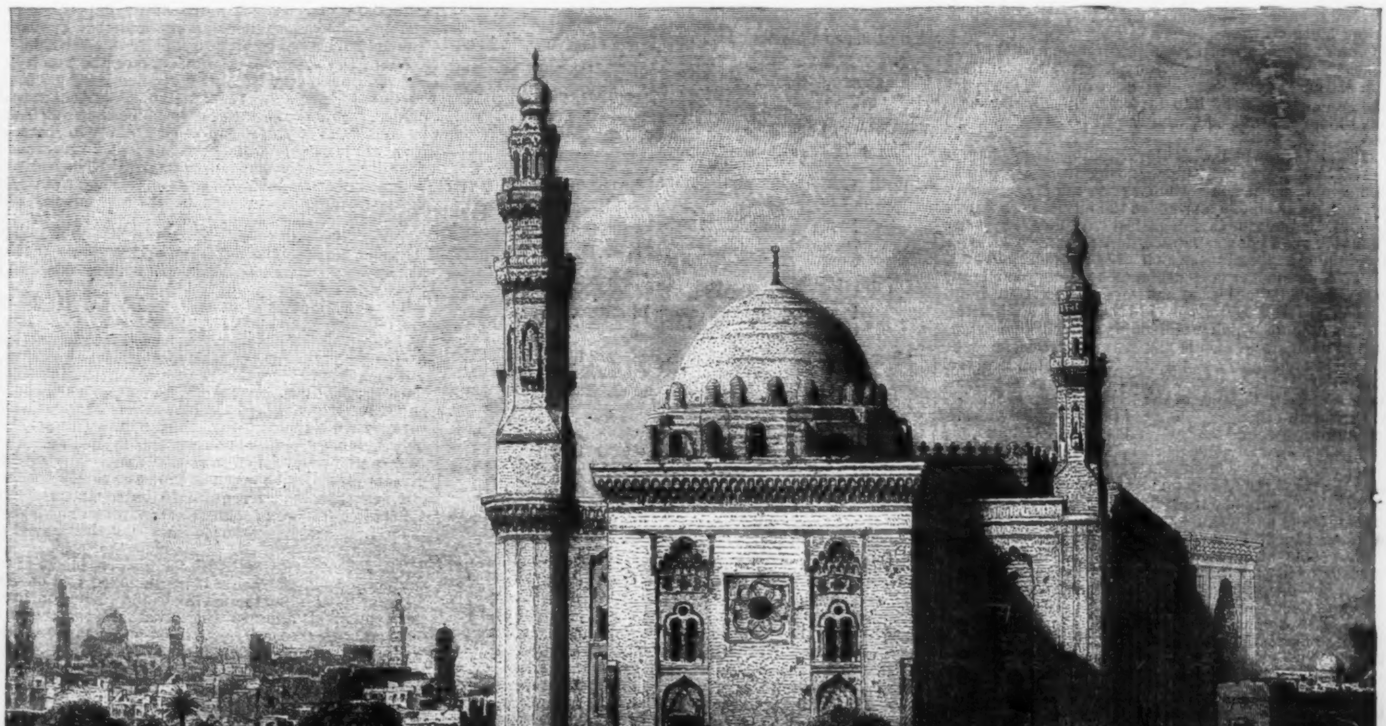
THE WAR IN EGYPT.—THE ARMORED TRAIN ON THE RAILWAY NEAR ALEXANDRIA.

CAIRO.

By REV. JAMES M. LUDLOW, D.D.

THE vast issues now pending in Egypt, involving nations, races, and religions, give an additional interest to its various localities, the details of its history, the peculiarities of its people, and, indeed, to everything associated with the land. But Cairo, its capital, does not need the roar of European guns to make it the center of the world's curiosity. Perhaps there is no spot on earth at which more lines of general interest converge.

Let the reader stand with me, in imagination, upon the wall of the citadel which rises above the city. That silver gleam winding down at our left is the Nile, whose source has been the geographical enigma of all centuries, whose



CAIRO, EGYPT.—THE SQUARE OF ROUMELEH AND THE MOSQUE OF SULTAN HASSAN.

annual overflow redeems from the desert a narrow ribbon of fertility, which has nourished the mightiest empires, and whose combined mysteries and beneficence drew men to worship it in one of the earliest and most influential religions of mankind.

Beyond the river, beneath the sands of the Libyan desert, lie the buried ruins of ancient Memphis, where the prostrate colossal statue of Remeses II., like some giant guard asleep at his post, has been on duty for three thousand years. A little to the north, and within an easy carriage drive of a morning, rise the great Pyramids, the largest and oldest works of man. So vast were they, that though they have been frequently used as quarries for palaces, fortifications, and mosques, they are not from this distance visibly diminished. Around them are tombs and temples in which are buried the secrets of remotest antiquity, over which the Sphinx watches with his motionless lips.

On this side of the river lies the suburb known as Old Cairo, by many believed to be the Babylon mentioned in the 1st Epistle of Peter, and certainly that Babylon to which Strabo refers, and whose old Roman fort is still visible above the accumulated *débris* of two thousand years. If the traditions of the place are to be credited, the great rock within the Jewish synagogue here, which is kept so sacredly covered, was the pulpit of the ancient prophets of Israel, from which, when upon their missions to the faithful "scattered abroad," they announced the oracles of Jehovah. In a niche high up in the wall of this synagogue is kept a yellow manuscript of the books of Moses, which the Rabbi will solemnly declare, as have done his predecessors from time immemorial, to be a copy of the Law prepared by Ezra. Here is a Coptic church commemorating the flight of the Holy Family into Egypt, built upon the traditionary site of their temporary home. Though the traditions are not reliable, there can be no doubt of the great antiquity of these structures. It is evident from their architectural style, from the fact that the marble pillars in them have been deeply worn by the shoulders of the generations of worshipers who have leaned against them, as well as from the elevation of the streets with the accumulation of refuse, so that one must now descend, whereas originally the worshipers went up into the courts of the Lord's House.

This section was made the capital of Egypt as early as 638 A.D., when Amer, the general of Khalif Omar, first conquered the land for the Moslem faith. The Mosque of Amer still stands. One of its 366 marble columns is a monument of the persistent credulity of the Mohammedans. On it is a purple vein which the faithful believe to be the mark of the Khalif's whip, under which, and the invocation of the name of the prophet, the column flew through the air from Mecca to its present position. This Old Cairo is now occupied chiefly by Copts, the oldest existing denomination of Christians, and the nearest, if not the lineal, descendants of the ancient Egyptians.

Directly before us, as we look north from the citadel, lies Cairo proper. The city was founded by the Fatemite princess in 969 A.D. The planet Mars, or Kaher, being then ascendant, they named the city El Káherah, from which the present pronunciation, Cairo, is derived. The forest of minarets and domes, houses and tombs, marks every generation since.

The citadel from which we look down upon these petrified ages is an immense pile, erected upon a vast mound of rock by Saladin the Great in 1170 A.D., in order the more effectually to resist the assaults of the European armies whose crusading zeal in the Holy Land he afterward so signally baffled. What wars have raged against these walls! What terrors have reigned within them! It has been the very heart of Egypt during the wild convulsions with which the Ayoobite and various Memlook dynasties, the Turkish Pachas and Khedives have striven successfully for power. Modern interest centers in that feast of blood with which Mohammed Ali, the founder of the present family of Khedives, on March 1, 1811, horrified the world. Having invited the Memlook nobles into his council, at a signal he massacred them all, save one, who leaped his horse over the parapet.

The citadel is crowned with the magnificent Mosque of Mohammed Ali, whose vast dome, rising from a group of semi-domes and sentineled by tall white minarets, pierces the sky, and gleams like a star above the city. Both within and without, the mosque is embellished with most expensive art. The rich colors of the painted dome contrast with alabaster columns and casings which give it a soft and fairy effect. The Roumelian adventurer who annihilated the Memlooks, baffled the Turks, and made himself an indispensable ally of the European powers, sleeps within this splendid mausoleum which he erected; and Moslem priests are praying by his tomb while the parasite government he fastened upon the country still drains its blood and treasure.

A natural division of the city would be into two sections, the one of the dead, the other of the living; for large districts of it are given up to tombs. Many of these are really memorial mosques, in which lie the bodies of the Caliphs and Memlook princes. Here and there is a rich man's tomb, at the window of which is a running stream of water and a cup, that the thirsty may drink and bless the memory of the departed. How many of our professedly Christian men have built magnificent monuments to their greed, but have not left so much as a little fountain of additional comfort to those who come after them! Most of the tombs are unsightly slabs or plastered mounds, hardly distinguishable in color from the deep dust which, unlike our green grass, glares around them. These cemeteries are perfect Tophets of filth, the lair of mangy dogs and lazared men. The city of the living is majestic from a distance, with its homes of nearly 400,000 people, and its 400 mosques. But when we descend into it we find it compact with as much squalor and misery as can be found elsewhere within the same limits on the globe.

THE MOSQUE OF HASSAN.

The finest mosque—next to that of Mohammed Ali—is that of Sultan Hassan. This was finished in A.D. 1360. Its minaret is the highest reach of Mohammedan architecture in the world, 280 feet. Its portal rises a hundred feet above our heads. Originally the mosque was noted for its splendid carvings of that peculiar pendent design which marks the Arabian order, but now everything shows neglect. Ornaments and windows are broken, and the spider seems the only diligent custodian of the place. At the portal you will be met with the mandate, "Take off thy shoes from off thy feet," but this you may do metaphorically by putting over your boots great slippers made of straw, with which you may shuffle in.

First is the court, open to the sky, in the center of which is the fountain of ablution. Beyond is the church proper, a vast room, unfurnished except with a flight of steps, from the top of which the priest occasionally preaches. At the end is an indentation marking the direction of Mecca, toward which the faithful pray. In one corner is the tomb of the old Sultan Hassan, a massive sarcophagus of stone, not harder than the heart of him who has mouldered beneath it. Here and there, crouching in corners asleep, or praying on the dirty pieces of matting, are the devotees. Brown stains on the stone floor tell of many tragedies which have been enacted within it. Having seen one mosque we have seen all, for there is little difference between them, except of size, original ornamentation, and present dilapidation.—*Illustrated Christian Weekly.*

THE ROLLING STOCK OF THE ST. GOTHARD RAILWAY.*

By R. Abt.

Although this railway is to be opened to traffic this year the rolling stock is still wanting, and great discussion has taken place on the question, especially as to whether the engines are to be tank or tender engines. While the existing Alpine lines are satisfactorily worked by tender-engines, the frequency of good water stations on the St Gothard, with other advantages, spoke strongly for the use of tank-engines. To decide this and other questions a careful study has been made of the locomotive working in Switzerland and other countries.

The total length to be worked by the engines of the St. Gothard line, including four branches, may be taken at 291 kilometers (180 miles). It was at first considered that the yearly traffic for the first ten years might be taken at 200,000 passengers and 400,000 tons of goods Subsequently the estimate has been raised to about 250,000 passengers and 450,000 tons of goods; the traffic being, of course, greater on the main line through the tunnel, and less on the branches.

With regard to the ratio between dead weights and paying weights, it appears that on the Swiss railways the number of seats occupied as compared with the number provided, taking the average from 1874 to 1879, was 30·2 per cent. On the St. Gothard line it was estimated that it would be 40 per cent. Again, the paying load for goods during the same years on the Swiss railways averaged 27·51 per cent. of the gross load. Owing to the heavy traffic of the St. Gothard Railway the proportion was estimated at 40 per cent. The dead weight of carriages per seat provided, for four-wheeled American cars, varies from 221 to 305 kilogrammes. For the carriages of the St. Gothard line it is 266 kilogrammes for four-wheeled and 186 for eight-wheeled carriages. On the whole a weight of 250 kilogrammes per seat may be assumed, which is equal to 605 kilogrammes per passenger, or 700 kilogrammes for passenger and dead weight together. Again, the average of the Swiss lines for goods wagons is 0·55 ton as the tare per ton gross weight hauled, and since only 40 per cent of the gross capacity is utilized, the dead weight per ton of paying load is 1·375 ton, giving 2,375 tons as gross weight per ton of paying load. Hence results the following as the estimated traffic on the various divisions of the St. Gothard Railway:

Line.	Traffic.	Gross weight hauled per annum. Tons. (The metric ton = 0·9842 av. ton.	Ditto per day. Tons.
Immensee to Bellinzona..	Passenger.	19,600	537
	Goods. ..	187,500	3,254
Bellinzona to Chiasso. ..	Passenger.	175,000	480
	Goods....	960,000	2,606
Bellinzona to Pino......	Passenger.	175,000	480
	Goods....	237,000	651
Bellinzona to Locarno...	Passenger.	105,000	288
	Goods....	23,750	65

With regard to speed, the actual speeds on the Mont Cenis (gradient 1 in 33) are:

Express trains....15 to 18 miles an hour.
Ordinary " ....14 to 16 " "
Goods " ....12 to 14 " "

On the Brenner-Semmering the speeds are:

Passenger trains, average 12 miles an hour.
Goods " " 7 "

Herr Gottschalk holds that a goods engine on such lines, gradient 1 in 40, should never exceed 9 miles an hour. Herr Hellwag fixed the conditions for the St. Gothard Railway as follows:

		Miles an hour.
In the valley, max. gradient 1 in 100..........	Passenger trains,	27
	Goods "	10
In the mount'ns, max. gradient, 2·7 in 100	Passenger "	13
	Goods "	7
In the tunnel, max. gradient 2·58 in 100......	Passenger "	18
	Goods "	9

With regard to the number of trains, allowing four hours out of the twenty-four for delays, and that passenger trains are thirty-one minutes, and goods trains sixty-three minutes, between Göschenen and Airolo, the possible number of trains per day would be twenty-five. If a crossing place were provided in the tunnel, the number could be raised to thirty-seven. With regard to the train loads, the terrible effects of a train breaking loose on such a line make it necessary to limit this according to the strength of the couplings. Even with the latest form of couplings it is considered that the total stress should not exceed 6¼ tons. On the Semmering, on gradients 1 in 40 and curves of 200 yards radius, this stress is reached with goods trains of 200 tons. On the St. Gothard Railway the gradient is 1 in 37, but the curves have only 300 yards radius. The result will, therefore, be the same, and the greatest weight of train must, therefore, be taken as 200 tons.

The locomotives necessary for conveying the traffic under these conditions for the first year were estimated as follows:

12 engines, 4-coupled, 25 tons adhesion weight.
19 " 6 " 38 " "
17 " 8 " 52 " "
— —
Total 48 " 1,906 " "

For subsequent years the number was taken at eighty. The railway already possesses fourteen engines, and thirty-four new ones will therefore be required when the line is opened. In October, 1880, the directors contracted for the supply of thirty-seven engines as follows:

Six tank-engines, four-coupled, with a four-wheeled bogie, for the passenger trains on the valley sections: diameter of cylinder, 16½ inches; stroke, 24 inches; total heating surface, 1,120 square feet; weight loaded, 42·7 tons; smallest adhesion weight, 22·5 tons.

Fifteen tank-engines, six-coupled, with a radial leading-axle, for passenger trains on the mountain section: diameter of cylinders, 18·8 inches; stroke, 24 inches; total heating surface, 1,302 square feet; weight loaded, 51·5 tons; smallest adhesion weight, 33 tons.

Sixteen tender-engines, with six wheels all coupled, for goods trains: diameter of cylinders, 18·8 inches; stroke 25 inches; total heating surface, 1,378 square feet; weight loaded, 61 tons; smallest adhesion weight, 38 tons. These engines have tanks for carrying 4 tons of ballast water, to bring up the adhesion weight, if required, to 42 tons.

The building of the heavy tank-engines was subsequently suspended.

The council of management of the railway have pronounced the above type of tender-locomotive to be ill-adapted to the railway, and the number insufficient.

In comparing the two classes—tender and tank engines—it will be assumed that the tank engines have 42 tons as adhesion weight at starting, with 10 tons on the leading axle, and that the tender-engines have the same adhesion weight, with a tender weighing 11 tons empty, and 23 tons full.

The following are the advantages of the tender-engine: (1) Simplicity, (2) accessibility of parts, (3) lower level of center of gravity, (4) greater range in choice of construction and dimensions, (5) constant load on the axle, (6) constant tractive force, (7) greater tendency to preserve the direction in case of derailment, (8) more room for water and coal, (9) consequent capability of taking a worse quality of coal, (10) less risk for men and passengers in accidents, from the presence of the tender, (11) use of strong tender-brakes.

The disadvantages are as follows:

(1) Overhang of the fire-box, causing objectionable and dangerous oscillations, (2) stiffness of the coupling between engine and tender, (3) great wear of the leading wheel flanges, (4) consequent wear of permanent way, (5) greater probability of derailment from this cause and increased cost of maintenance, (6) large difference between the total weight and the weight utilized for adhesion, occasioning either the too heavy construction of some parts, or the carrying of ballast, (7) impossibility of completely inclosing the driver's stand.

On the other hand, the advantages of the tank-engine, with free leading axle, are as follow: (1) Secure fixing of the boiler, (2) easy traveling, (3) safety on curves, (4) low resistance on curves, (5) uniform wear of the wheel flanges, (6) reduced wear of the permanent way, (7) possibility of inclosing the driver's stand.

The disadvantages are as follows: (1) Variable load on axle, (2) variable tractive force, (3) confined space for driver, etc., (4) difficulty of access to some parts, (5) tendency to leave the direction in derailment, (6) loss of the tender-brakes.

As regards repair and maintenance, experience shows that a tank-engine costs more than a tender-engine; but not more than engine and tender together.

On the St. Gothard Railway it would not pay to burn inferior coal, as the freight is very heavy; hence the large coal space of the tender-engine is not needed. The leading bogie is not, of course, a feature of tank-engines alone, but its use is there much more easy and valuable. The question of tender-brakes has lost much of its importance now that many goods wagons have brakes, and that automatic continuous brakes are coming so rapidly into the field.

As to the efficiency of the engines, the gradient in the Kehr tunnel on the Northern division is 2·3 per cent. The continual wetness of the rails diminishes the resistance on curves, but also diminishes the adhesion, which must not be calculated at more than one-eighth. On the south side there are gradients in the open up to 2·7 per cent., so that the adhesion is the same on both sides. The resistance may be taken as 0·005 ton per ton of engine and train. Then the greatest weight hauled will be 187 tons, giving 122 tons of train-load for the tender engine, and 135 tons for the tank-engine. The latter will, of course, lose tractive force, as its water and coal diminish; but it appears that when it has lost 5½ tons its train load will still be equal to that of the tender-engine.

The consumption of fuel may be taken as for the Brenner, viz., 94 kilogrammes (207 lb.) per 1,000 ton kilometers. The weight of the trains may also be assumed as the same, say 65 tons. This, with the tank-engine, gives a total weight of 110 tons. It follows that the whole length of 90 kilometers, from Erstfeld to Biasca, might be run with 900 kilogrammes (1,980 lb.) of coal, and 7 cubic meters of water, and therefore without replenishing. There must always, however, be a stoppage before entering the tunnel, and water and coal can be easily taken in at that time. The weight of the goods trains may be taken at 120 tons, or 169 tons with the engine. This would require 10 cubic meters of water and 1,400 kilogrammes of coal. Coal and water must therefore be taken in once during the journey, whether tank-engines or tender-engines be used.

The lower dead weight of the tank-engine is, of course, a saving in point of fuel. It is calculated that on the mountain part of the line the saving would amount to 4,200 francs per annum. It appears, then, that tank engines are equally efficient, safer, easier in running, and more economical, in wear and tear and in fuel, than the corresponding tender engines. Since some tender-engines have already been ordered, it can only be suggested that half the stock should be in one form and half in the other.

As to the performance of the engines, the number of engines employed on the five main Swiss lines in the summer of 1880 was as follows:

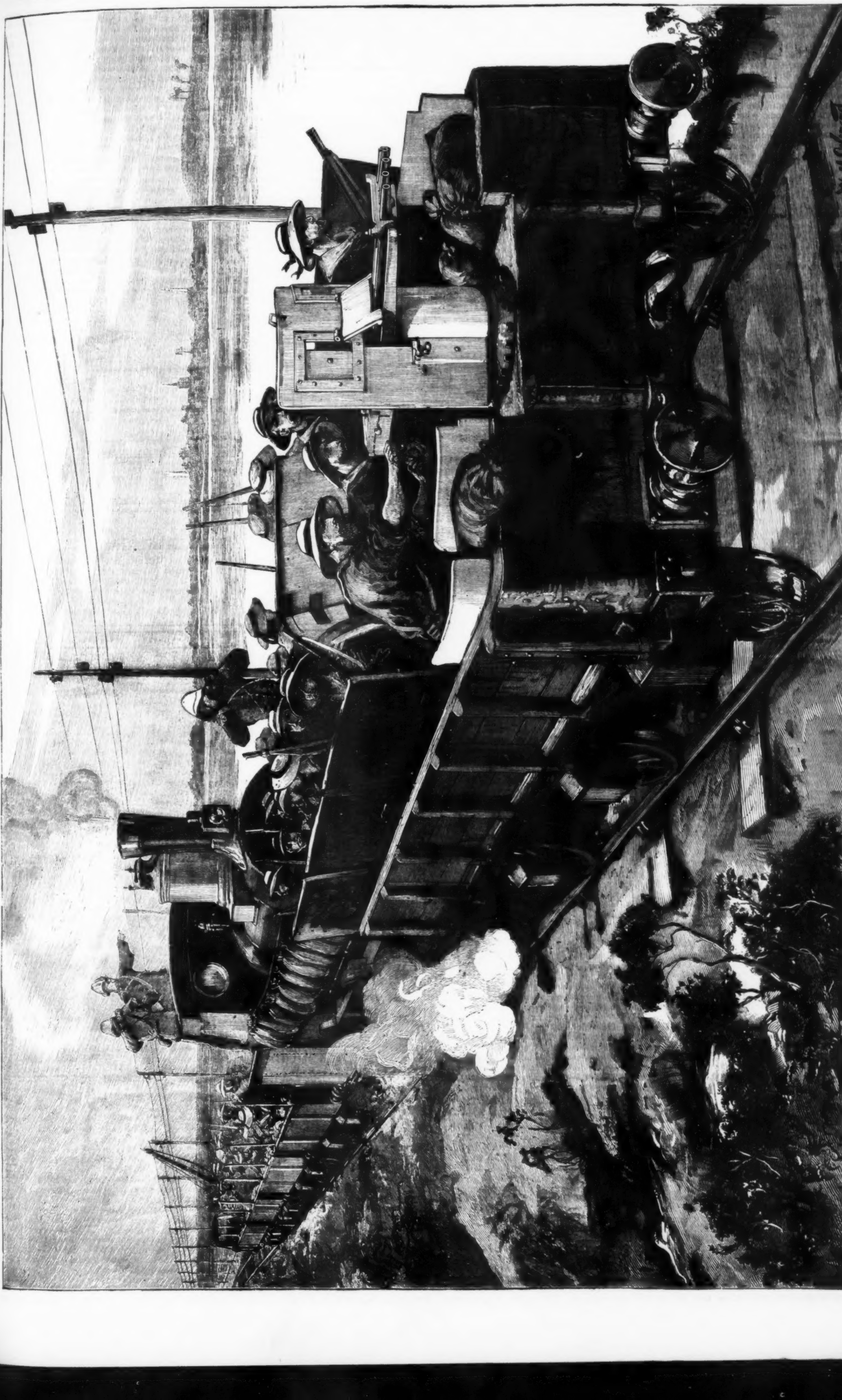
In service 276, or 60·8 per cent.
In reserve 71, or 16·6 per cent.
Under repair 107, or 23·6 per cent.

Taking these in round numbers as 60, 20, and 20 per cent., it is found that the St. Gothard line will require fifty-one engines in all.

The annual mileage of the engines on the Swiss normal lines has steadily declined from 30,393 kilometers, in 1874, to 24,839 in 1879. Herr Hellwag assumes that, on the St. Gothard line, the passenger engines will run 30,000 kilometers, and the goods engines 34,000 kilometers per annum, on the mountain section. The question here is the time that the drivers' firemen will practically work in each twenty-four hours.

On the Swiss railways the average time is 15¼ hours per day in service, of which 7¼ are actual running. In Germany the figures are 17·4 and 9·6 respectively. On the

* From "Organ fur die Fortschritte des Eisenbahnwesens," for Transactions of the Institution of Civil Engineers.



THE WAR IN EGYPT: THE BRITISH ARMORED RAILWAY TRAIN.

French East Railway they are 10 and 5 for express trains, 10 and 6 for passenger trains, and 12 and 7¼ for goods trains. On the Belgian railways the average is 10¼ hours in service. For the St. Gothard Railway the hours of service may be assumed to be 14, of which 6 will be actual traveling, for quick trains, and 9 for slow trains; and this for two hundred and twenty days per annum. Assuming the speed to be 22 kilometers per hour for quick trains, and 12 for slow trains, it is found that the passenger engines will run 43,000 kilometers, and the goods engines 24,000 kilometers per annum, on the mountain section of the line. On the valley sections, where the speeds are 45 and 17 kilometers, the corresponding numbers will be 48,000 and 30,000 kilometers per annum. These figures are confirmed by the mileage of certain engines on the existing Swiss railways.

To obtain a high mileage for locomotives the following are the chief points to be attended to:

(1) The engines must be properly constructed, and of good material.

(2) There must be a good distribution of the work, both for the drivers and the engines.

(3) There must be a well-equipped workshop, to make sound and rapid repairs.

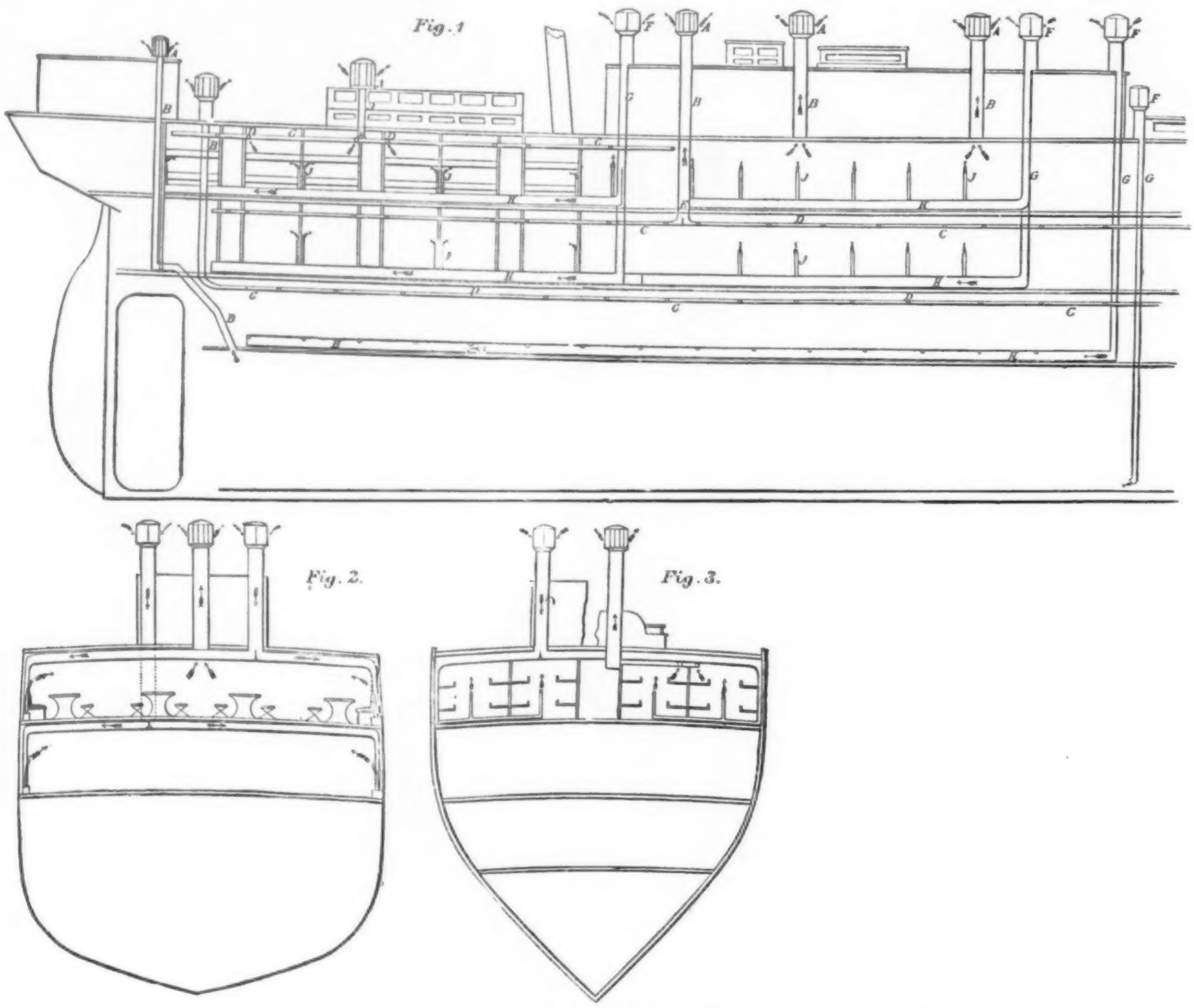
As an illustration of No. 2, the total weight taken over the Mont Cenis line in 1878, exclusive of engines, was 1,024,500 tons, or 2,807 tons per day. This was hauled by thirty-seven engines, having a total adhesion weight of 1,798 tons. Adding the tenders at 20 tons each, the total engine weight working per day was 2,538 tons, to haul only 2,807 tons of train load; in other words, the engine weight 90 per cent. of the train weight, and three times as great as the paying weight.

A table is given, which shows the amount of traffic which could be worked over the St. Gothard line by the thirty-one engines ordered, assuming their performances to be as above described. It appears that the performance of the passenger engines would be greater than that estimated as necessary on the line, but that of the goods engines considerably less. This difficulty might be overcome for a time, if the directors resist the temptation of opening the line with a large service of trains, which, in the case of a trunk line across a mountain chain, is quite unnecessary. It remains, however, that they should at once proceed with the design and construction of goods engines of a more powerful character. The type of these engines will be mainly determined by the three following conditions: (1) Utilization of the whole weight for adhesion; (2) fixed wheel-base of less than 3 meters; (3) load per axle of not more than 12 tons.

On the Austrian Southern Railway an eight-coupled engine, of 52 tons adhesion-weight, hauls a train of 200 tons total weight (the maximum which has been suggested for the St. Gothard line), including 25 tons for the tender. A 70-ton tank-engine, with twelve driving-wheels, would haul, with a smaller consumption of fuel, about 30 per cent. more of train-weight than the tender-engine; in other words, would take up in three trips a weight for which the other would require four. Such a double six-coupled engine would practically haul 300 tons across the mountain, and could thus convey the maximum daily train weight of 3,250 tons in eleven trains; adding four mixed and ten passenger trains, the total number per day would be twenty-five; which could be worked without a crossing place in the great tunnel. The conclusion is that twelve-wheeled engines of this kind, more or less resembling the Fairlie type (of which three hundred have now been built) should be used for the St. Gothard line. [It is not stated how the difficulty of excessive strain on the couplings is to be got over.]

VENTILATION FOR SHIPS.

THE ventilation of ships is a matter of such great importance financially as well as physically, that it is simply surprising so little advancement has been made in the way of improving a state of affairs on board ship, which as they exist at present is certainly anything but creditable to shipowners and shipbuilders throughout the world. Improvements of every kind connected with the working parts of a ship are eagerly sought after and applied, but the one thing that would not only effect a saving of millions of pounds annually—this is no exaggeration—but also save hundreds of valuable and useful lives, and insure the health and comfort of millions of human beings, has been almost totally neglected and ignored. It is very shortsighted economy indeed; the attempt to keep down expenses by adhering to the old-fashioned, unscientific, and certainly most ineffective ventilating appliances which are usually found on board ship, and which consist principally of a pipe having a bell-mouth or trumpet-shaped head which may be useful under certain conditions for driving down air, but is of little or no use as an extractor of the foul air, which after all is really what is required if the ventilation is to be satisfactory and safe.



BOYLE'S SYSTEM OF VENTILATORS FOR SHIPS.

The special disadvantages of the bellmouth ventilator are that it requires trimming to suit the direction of the wind, and this necessitates a certain amount of attention that is not always given. Owing to the down draught which it causes when applied to passengers' or the crew's quarters, it is in cold weather generally stopped up, clandestinely or otherwise, as the case may be, when any ventilation it might have afforded is of course at an end, and partial asphyxiation ensues with all its attendant miseries and dangers. When applied to holds for the ventilation of cargoes the results are, if possible, still more serious, as the evaporation of moisture and exhalations of gases which are generated and thrown off from most cargoes are precipitated and pressed down by the rush of cold air through the ventilator, and made to resaturate and charge the cargo with those deleterious and dangerous bodies to such an extent as to not only deteriorate the quality of the goods, but prove a positive source of danger through the collection of compressed moisture and gases, often resulting in spontaneous combustion. Grain and fruit cargoes are specially liable to suffer through defective ventilation, and the loss in this respect that occurs annually it would be interesting but startling to know, as we feel sure the amount must be very great. Coal-laden ships come under the classification of dangerous, where proper provision is not made for the free escape of the gases evolved and allow of a free circulation of air through the whole cargo. But what ship can be named where this is to be found? The bellmouth ventilator is the chief delinquent whenever an explosion from spontaneous combustion occurs, blowing the ship to pieces and her crew into eternity, which unfortunately, as the daily papers but too frequently apprise us, is not of uncommon occurrence.

We look forward with hope, however, to the report of the Royal Commission which is at present examining into the ventilation of ships, and trust it may be able to remedy the evil, which is certainly a trying one, by suggesting some plan for rendering it compulsory for all British ships to be properly ventilated. The Doterel explosion, the inquiry into which the commission is the outcome, may thus be the cause of saving many lives in the future and much valuable property, and verifying the old Scriptural saying that "out of evil cometh good."

In stormy weather the bellmouth ventilator has to be closed up to prevent water passing below, and with everything battened down, the sufferings which are endured in cattle and passenger ships may be more easily imagined than described. In cattle ships the poor animals die in large numbers, those which are fortunate enough to reach their destination alive are in a wretched condition and present a most pitiable appearance. Their systems are also so poisoned with the foul and fetid air they have been forced to breathe, that when killed the meat is much inferior to what it would otherwise have been, and is by no means so beneficial to the consumer. Who is there who has ever traveled by sea, and who has not had reason to remember the disagreeable odors which usually infest all parts of a ship between decks, and has not experienced a sensation of nausea and sickness whenever necessity compelled him to go below? This is entirely owing to defective ventilation and need not exist at all, as with proper appliances between decks may be kept almost as sweet as on deck. It is not to be supposed, however, that there have been no attempts made on the part of inventors to supply such a felt want as an efficient method of ventilating ships; on the contrary, there have been many plans and systems introduced from time to time, but the most of them unfortunately have been of such a complicated nature that they were either too expensive and difficult to apply and maintain, or they were so liable to get disarranged as to render them practically useless. We have always maintained that a system of ventilation which could be universally applied must be of such a nature that it cannot get out of order, is independent of any special attention, is self-acting in every part, and is always in action when the vessel is sailing or lying calmly in harbor.

A system of ship ventilation that appears to fulfill all these requirements is the one invented by Messrs. Robert Boyle & Son, the well-known ventilating engineers of Holborn Viaduct and Glasgow, and which gained the "Burt" prize of £50 offered for the best system of ventilation for ships at the Shipwrights' Exhibition, held in Fishmongers' Hall in May last. The competition was international, there being six entries in all, two of them being American. The judges awarded the prize for the combined simplicity and efficiency of the system. The award was taken exception to by one of the American competitors, and out of courtesy, we presume, to a stranger, the judges reconsidered their decision, with the result of becoming more firmly convinced of the superi-

ority of Messrs. Boyle's method, and of the justness of the decision they had come to. All this, of course, renders the prize more valuable to Messrs. Boyle. His Royal Highness the Duke of Edinburgh, on the occasion of his visit to the Exhibition, took considerable interest in the system as shown in plans and models, and expressed his approval of it, commending its extreme simplicity. A modification of the system has already been applied to a large number of vessels with, we understand, considerable success; indeed, we fail to see how it could be otherwise, and Messrs. Boyle have received some very valuable testimonials from Her Majesty's Royal Navy and a number of the leading lines of ocean-going steamers.

The arrangement, which we illustrate, is somewhat similar to that applied so successfully by Messrs. Boyle to dwelling houses and public buildings, and consists of upcast and downcast ventilators. The upcast ventilator or air pump, which we have before described in these columns, is so constructed that no matter from what direction the wind may impinge upon it, an up draught is the result, there being no down draught. It is a fixture, having no movable parts to get out of order, and never requires trimming, so that the ventilation cannot suffer through want of attention, which is very important. It has also the great merit of being perfectly water tight, Messrs. Boyle having recently effected an improvement upon it, which effectually prevents a single drop of water passing through it, even though a heavy sea broke over it. It is fixed on deck in a similar manner to the ordinary ventilator.

The downcast ventilator is an exceedingly simple, but certainly most ingenious contrivance, as it is made to send an abundant supply of fresh air below and at the same time no water can pass down the shaft. It consists of four openings or mouths, something similar to the bellmouth, but contracted at the top of the shaft where they converge into one, so arranged that they catch the wind from every quarter without the necessity of trimming, it like the air pump ventilator being a fixture. Inside and about one third the length of the pipe above deck an oblong tube is fixed at the bottom of the bend, and round the sides a series of louvers are arranged so as to allow any water which might pass in at the mouths of the ventilator to escape into the outside pipe and thence through a suitable opening on to the deck. With these appliances it is, therefore, possible to have the ventilation going on between decks without any interruption or stoppage when there is a storm blowing with the seas sweeping the decks, whereas under ordinary conditions and in similar weather everything would be battened down and the ventilation *nil*.

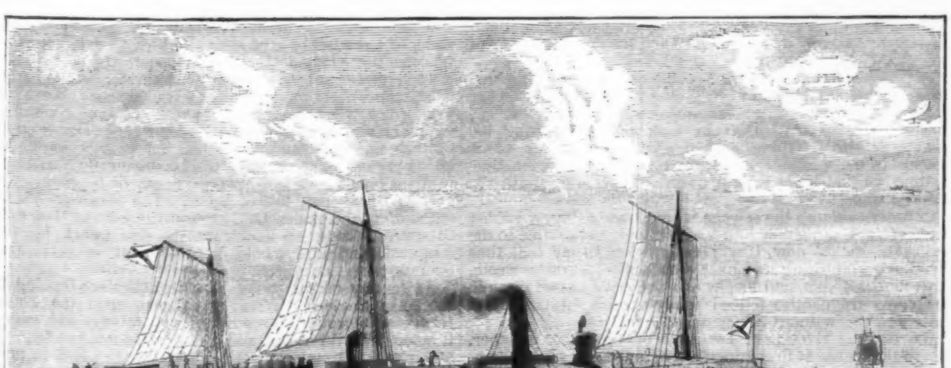
Fig. 1 is a longitudinal section of a steamship showing the arrangement of the pipes for distributing the fresh air and extracting the foul air from the different parts of the ship. A is the air pump extraction ventilators; B, main extracting shafts; C, branch extraction pipes led under the ceiling through the different cabins into which run other smaller pipes from other cabins; D, foul air exit openings into extraction pipes from cabins; E, partition plates to prevent currents in branch pipes meeting and creating an eddy, and also to deflect the currents up the main shaft; F, downcast ventilators; G, main supply pipes; H, branch supply pipes to cabins, saloons, etc.; I, small vertical tubes to admit the air in an upward direction and so avoid draughts. These tubes are fitted with regulating valves, so that the air supply is completely under control; when it is desired, the air supply may be warmed by having small hot water pipes led along inside the branch pipes and connected with the boilers. The air can also be cooled by means of ice-boxes placed in different positions in the shafts, so that in winter the air can be had of a genial warmth, and in the summer of a refreshing coolness.

Figs. 2 and 3 are transverse sections of saloon and cabins showing cross pipes.

Travelers by sea will very soon find out which are the most comfortable and healthy vessels to travel in, and it may be depended upon that they will always prefer those which are properly ventilated to those which are not; it is to the interest, therefore, of shipowners to adopt a system which experience has shown can be relied upon, or at all events to make some efforts to improve the ventilation of their vessels, not only for promoting the comfort of passengers, but for increasing the safety of their ships, and reducing the chances of deterioration in cargo.—*Engineering.*

NEW RUSSIAN TORPEDO BOAT.

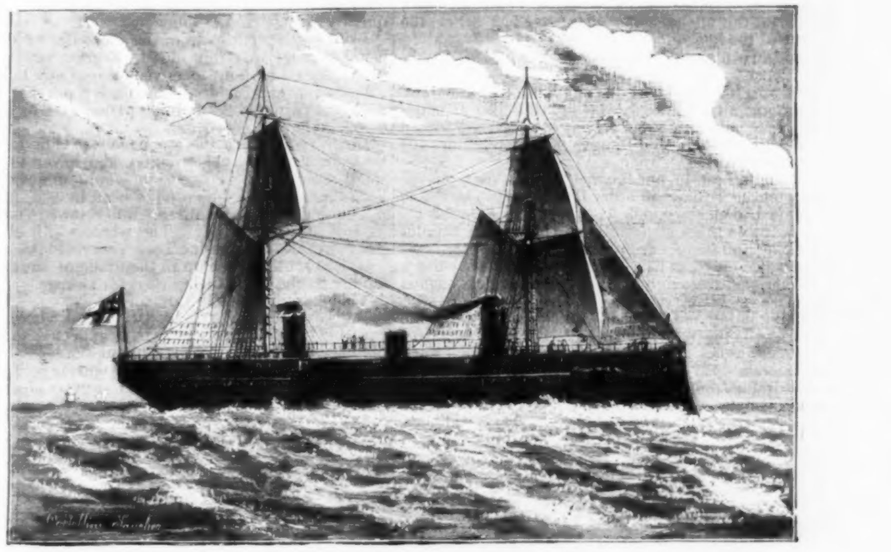
THE Batum is the name of a newly built torpedo steamer, of small size, lately constructed for the Russian Government. The boat is built of steel plates; length 100 feet, width 13 feet, has two screws, and moves 12 knots per hour. The hull is divided into several compartments, has turtle locked decks, a formidable bow-ram; and on each side of the bow is a horizontal tube for launching torpedoes. Everything in the machinery and torpedo line is made in duplicate.



NEW RUSSIAN TORPEDO BOAT.

THE AJAX.

THE Ajax is the name of a recent formidable addition to the British Navy, of which vessel we herewith give a drawing, for which we are indebted to *La Ilustracion Espanola y Americana*. The ship is approximately 285 feet long, and 50 feet wide; armor plates 20 inches thickness, extending 6 feet below water line. The hull is double, divided into compartments that have a filling of cork. She is provided with means for launching Whitehead torpedoes. She carries four 32-ton rifled guns, 17 inches caliber, mounted in rotary towers 20 inches thick. Speed 13 miles an hour. The particulars here given are only approximately correct. The vessel has been sent to join the English squadron in Egypt.



THE NEW BRITISH TORPEDO SHIP AJAX.

THE PULLMAN SEWERAGE.*

By BENEZETTE WILLIAMS.

THE town of Pullman is situated on the west shore of Lake Calumet, 5 to 6 miles west of Lake Michigan. It is 14 miles south of Chicago, on the line of the Illinois Central Railroad. It has been built by Pullman's Palace Car Company in connection with their Chicago Works. Besides the Pullman car shops there are now in operation at Pullman the Allen Paper Car Wheel Works, the Union Foundry and Pullman Car Wheel Works, the Dunning Steel Horseshoe Works, the Spanish American Curled Hair Factory, and large brickyards belonging to the Pullman Company. The Chicago Rawhide and Belting Works are to be built this season, and in the near future the Illinois Central Railroad shops and the shops of the New York, Chicago and St Louis Railroad are to be built on adjoining lands.

The industries now in operation have about 2,500 men employed. In building and various outside work, in addition to those in the shops, there are about 1,200 men employed.

On the 1st of June there were living at Pullman 625 families, with a population of 4,500. The population is limited by the number of houses ready to occupy.

Buildings which will accommodate 824 families are nearly completed, and enough for 570 more have been begun. It is fully expected that in one year from now the population will be as much as 8,000 or 10,000.

The buildings are of brick, and have been built in the most substantial manner.

Other objects than durability have been aimed at by its founder, from whom Pullman takes its name.

It is intended that the town shall be unique in more than one respect. Beside healthful homes, provisions are made for many comforts and enjoyments usually out of reach of the artisans and mechanics

It is a munificent effort on the part of concentrated capital, not only to furnish houses for workmen, but to provide for all the various needs of a civilized and cultured community. Stores and markets, the theater and the library, as well as churches and school-houses, have been made only secondary to dwellings and the workshop. The æsthetics of architecture and landscapings are made prominent features. The grouping of buildings and trees, to produce a pleasing effect, is studied as diligently as the arrangement of machines in the shop.

It is in this town, built upon land that two years ago was a wild prairie, that the system of sewerage which I wish to describe is in use.

In a late letter to the *Sanitary Engineer*, Robert Rawlinson defines his position, with reference to the separate and combined systems of sewerage, in these words: "As to town sewering and house draining in general, I do not wish do be considered wedded to any special system, combined or separate. There are cases in which I would exclude surface water—I have done so—and there are cases in which I would take in surface water, as I have done." To any one but a specialist this position would seem to be the only correct one.

In the sewerage of certain towns the propriety of adopting the separate system is apparent. In other cases its superiority to the combined system is not so evident. Pullman is a place for which the separate system is particularly well adapted, and for the following reasons:

The site of the town is almost level, much of it not more than 7 or 8 feet above the lake, making it impossible to obtain a gravity discharge to any other body of water than Lake Calumet. This lake is shallow, ranging from 1 to 8 feet in depth. It is about 3 miles long and 1½ miles wide. It drains a small area, and is connected with Lake Michigan by the Calumet River. The river, however, which drains a much larger area than the lake, does not run through the lake, but is connected therewith by a small channel, through which the water flows from the lake to the river, or from the river to the lake, according to the varying conditions of winds and floods.

In the absence of any adequate means of purifying itself, Lake Calumet is wholly unfit for a receptable for sewage.

The small elevation of Pullman and the great distance to Lake Michigan renders a gravity discharge thereto impossible.

When a town can not get rid of its sewage by a gravity discharge, the alternative is to use pumps. When pumps have to be relied upon, the exclusion of rain water from the sewers becomes almost a necessity. And when the surface water can readily be carried off by a system of drains made for that purpose only, as has been done at Pullman, it adds strength to the reasons for fixing upon the separate system, which in this case was adopted for the reasons given, independently of its supposed sanitary merits.

The question of disposal, however, was not one that could be settled by the force of conditions. In selecting the place for, and deciding upon the manner of, disposal, there was room for a greater range of opinion and judgment, though even in this the question was soon narrowed down to two parts.

Lake Michigan could be reached with a pipe 6½ miles long, and by pumping the sewage could readily have been discharged therein. The only practicable alternative was land purification in some shape.

It was found that suitable land could be had 3 miles away, the title to which had been acquired by the Pullman Land Association. Estimates showed that a pipe could be laid to this land. A farm sufficient to dispose of the sewage of 10,000 people prepared, and suitable farm buildings erected for a less outlay than would be incurred in laying a pipe to Lake Michigan. It was believed that the farm could be made to pay expenses, and the interest upon the money actually expended upon the farm proper, which would make the scheme of land purification considerably cheaper than the lake disposal, to say nothing of the objection felt to further contamination of a body of water that is in places already overcharged with filth.

The plan of sewerage was determined upon, and the laying of the sewers begun in August, 1880—soon after the writer was employed as engineer of the Water and Sewerage Works for Pullman.

Six months later, in February, 1881, the method of disposal was decided by the adoption of the sewage farm project.

October 18, 1881, the system was put into operation on starting the sewage pumps.

The system of sewerage is designed to reach a tract of land 2 miles long, and an average of something more than a mile wide, comprising about 1,500 acres of land.

To drain this district three mains have been provided, which center at the water tower, which is also the sewage pumping station.

The mains leading from the north and from the west are 18 inches in diameter, and the one leading from the south is

*A paper read before the Western Society of Engineers, June, 1882.

15 inches in diameter. These mains are laid with a grade of one foot in 1,000 feet.

The 9 inch laterals are laid with grades varying from 3 to 4 feet per 1,000 feet, and the 6 inch laterals with grades of from 4 feet to 6 feet per 1,000 feet, according to circumstances—the maximum grade in each case being the one used in all but special cases.

The minimum grades used are sufficient to give a velocity of 2 feet per second; a rather low velocity, it is true, but the best that could be obtained without large additional expense.

At the pumping station the mains are about 16 feet below the general grade of the town. The extreme ends of the 6 inch sewers in the alleys being about 6½ feet below the yards in rear of the houses.

The ground in which the sewers are laid is a hard, tough, drift clay.

Man-holes are 160 feet apart on the mains, and generally 200 feet apart on all the laterals; being built also at every change of grade and direction. They are covered with a ventilating iron cover, with a trough or channel under the openings to catch dirt.

It was thought best to put the man-holes closer on the mains than on the laterals in order that a scraper might be used to remove deposit which it was feared would accumulate, owing to their slight inclination; in the smaller sewers, flushing and the pill being relied upon.

In one instance only has it been found necessary to use a scraper. This was caused by a heavy rain which washed dirt into the sewer during construction.

The flushing appliances consist in connections of the water mains with the 9, 12, 15, and 18 inch sewers, and of automatic flushing basins on the house drains, which flush the 6 inch laterals.

The house drains from the sewers to the flushing basins are 6 inches in diameter. The horizontal pipe connecting the water-closets are 4 inches in diameter and are connected outside of the basins.

The sewage from sinks and wash bowls is usually carried outside of the houses separate from water-closet sewage, the former being admitted to the flushing basins, and used for flushing. These basins serve the purpose of grease traps, in preventing the accumulation of grease in the sewers outside of the basins. The siphons are so constructed that the grease and other scum is carried out of the basin when a flush occurs. The grease being cold and carried along with a strong current cannot adhere to the sides of the sewers. When the basins are properly built all the grease can be kept out of the basins by this means.

The houses being of one ownership and management, from four to six houses are connected with one basin for the sake of economy.

Another very effective method of flushing the mains, though not originally suggested as such, is by closing a valve in the pipe connecting the sewers with the sewage reservoir at the pumping station, until sewage has accumulated in the mains to as great a height as admissible, when by suddenly opening it excellent results are obtained.

In all there has been laid at Pullman up to June 1, 1882, the following amounts of sewers of the various sizes, exclusive of house connections, viz.:

4,356	lineal	feet of	18-inch	sewers.	
3,176	"	" "	15	"	"
680	"	" "	12	"	"
3,600	"	" "	9	"	"
12,000	"	" "	6	"	"
500	"	" "	4	"	"

Or, 24,312 lineal feet in all, which, with 130 man-holes, has cost about $50,000. This, of course, includes the most expensive part of the work, which was done, much of it, under very unfavorable circumstances, in very hard ground.

In all cases outside of houses, in mains, laterals, and house drains, salt-glazed, vitrified clay pipe of the Akron make have been used.

Within the houses, soil pipes are of iron, and were put in by the Durham House Drainage Company of Chicago. The vertical soil pipes are wrought iron, coated with coal-tar varnish, put together with screw joints; and the horizontal pipes are cast iron, with lead joints.

The vertical pipes are 3 inches in diameter, and the horizontal pipes 4 inches in diameter. The horizontal pipe connects with the outside sewer, without a trap. The vertical pipe runs through the roof in all cases full size.

In the most of cases, each soil-pipe has two or more water-closets connected with it. A pipe placed in a partition wall between two houses generally takes the soil for both houses. In cases of three-story flats, one pipe frequently has six closets connected to it.

By these departures from the usual size of pipes and the usual manner of setting closets, a great saving in cost has been effected without inconvenience of any kind.

Out of several hundred 3-inch soil pipes that have been in use from two to eight months, perhaps six or eight cases of stoppage have occurred.

In every instance the stoppage was due to obstructions that got in during construction, and never to the use of a small sized pipe. The results would unquestionably have been the same had 4-inch pipes been in use.

The sewerage system drains into a sewage reservoir in the base of the water tower. The whole width of the foundation of the tower having been excavated to a depth of 30 feet, and all the space up to the grade of the sewers, not occupied by the walls, being used for storage.

This holds about 200,000 gallons.

Increased storage capacity can be had when needed by excavating a side chamber. It is expected that the present capacity will suffice for 8,000 population.

Ventilation of the sewage reservoir is secured by means of eight flues lined with 12-inch sewer pipe, built in the buttresses of the tower and opening at a height of 165 feet, and also by a 20-inch pipe leading to the chimney of the car shops. The ventilation thus secured is perfect.

The reservoir is arched over with groined arches, forming a floor for the sewage and water pumps, 10 feet below the surface of the ground.

The sewage pumping engines are direct acting compound condensing, with piston pumps. Each having a capacity of 2,500,000 gallons in 24 hours.

They were made with the special object of getting machines which would pump everything to be found in sewage either of an ordinary or an extraordinary character. It was considered desirable to avoid screening or settling the sewage at the pumping station. All the sediment which collects in the reservoir by incidental settling, is from time to time washed loose with a hose and passed off with the liquid sewage.

In order to pump the sewage without screening, a rubber valve of special make is in use. Without taking time to describe the valves now, it will be sufficient to say that thus far they are working to great satisfaction. Cotton waste, large cloths, sticks, and blocks of wood have passed through the pumps frequently; indeed many of such substances are daily passing, without injury or inconvenience.

Barring the riveting of two parts of the rubber together, where they were at first imperfectly joined, no repairs have been needed, and there is nothing to indicate aught but a long life for the valves.

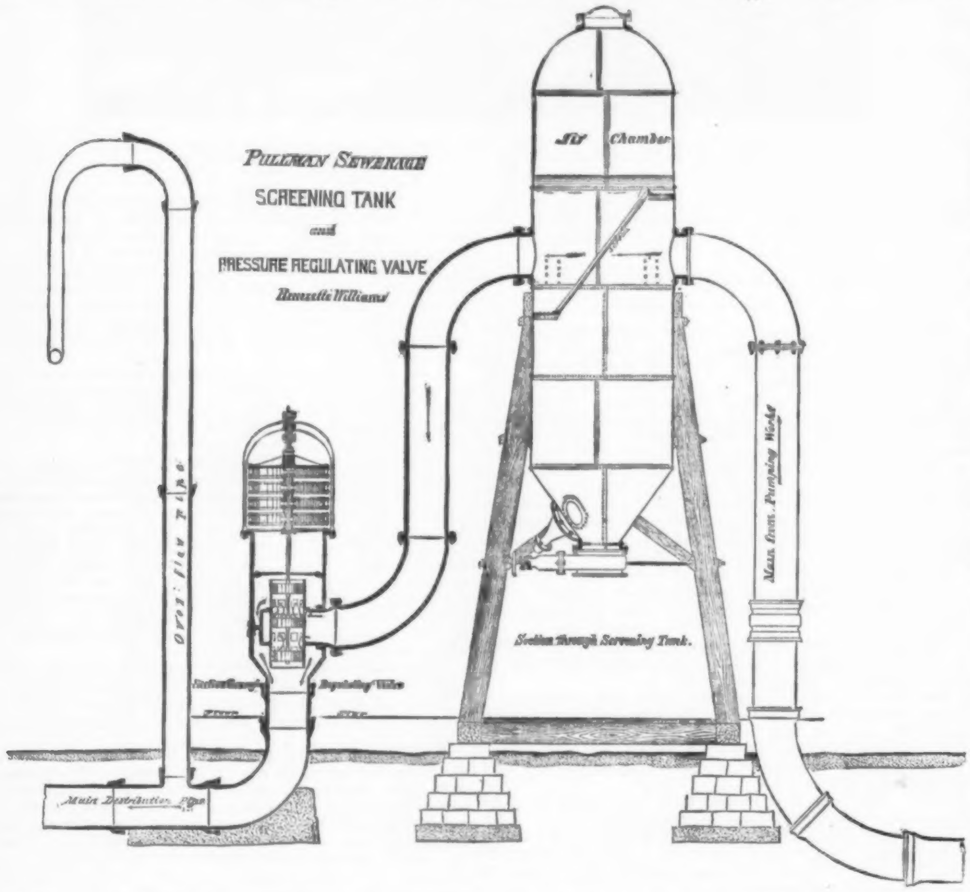
The pumps were made by the Cope & Maxwell Manufacturing Co., of Hamilton, Ohio.

The least amount of sewage during the latter part of May for twenty-four hours was, by pump measurement, 450,000 gallons. Of this I estimate that one-third is sub-soil water that finds its way into the sewers by soaking through the brickwork of the man-holes and occasional open joints, but mainly from a sewer that has lately been put in where water is admitted from unbuilt man-holes. The spring having been very wet, a large amount of water has been admitted through these incompleted man-holes.

The sewage is conveyed to the farm by a 20-inch cast-iron main, nearly 3 miles long. The farm end of this main connects with a closed screening tank, by means of which all material that will not pass through a screen of ⅛-inch mesh is intercepted. The tank is 6 feet in diameter and 24 feet long, made of ¼-inch boiler iron. It is set vertically, with its lower end high enough above the floor to admit of a wagon being driven under it. The material intercepted by the screen is lodged in the lower part of the tank, from which it is removed from time to time.

On leaving the tank the sewage passes through a pressure-regulating valve, which limits the pressure that comes upon the pipes leading to the fields to about 10 pounds. As an additional precaution against high pressure an overflow pipe is provided, which will absolutely, under all conditions, prevent the pressure from rising above the limit. This pipe comes into play occasionally when the pumps are started suddenly without giving the valve time to act. The valve is purposely made to act slowly, in order to avoid the influence of pulsations in the engines, and irregularities from other causes.

The action of the tank and valve is best understood by an examination of the accompanying drawing.



A pressure on the interior of the thin steel disks above the valve raises the plunger, and closes the ports through which the sewage passes. If the pressure falls the ports open gently. Vibrations of the valve from sudden changes of pressure are prevented by a plate between the valve and the steel disks, through small holes in which the sewage has to pass in order to increase or diminish the pressure on the disks.

The upper part of the tank above the screen is an air chamber, and answers the usual purpose of such an adjunct in preventing shocks from irregularities in the pumps, or by the sudden stopping of the flow of sewage.

The tank and valve are housed in and can be kept warm to prevent freezing in cold weather.

The reason for introducing the pressure-regulating valve between the screening tank and the field is to make it possible to distribute sewage safely through clay sewage pipes under pressure.

The main distributing pipe is 18 inches in diameter. From this main four lines of 9-inch pipes, 315 feet apart, are laid across a 60-acre field. Every 320 feet on each line of 9-inch pipe a hydrant is set, thus giving one hydrant to each 2¼ acres or thereabouts. On an 80-acre tract, which is now being underdrained, it is probable that two lines of 12-inch pipes will be used to distribute the sewage. This tract lies more favorably for surface distribution than the one prepared last year, and it is believed that fewer lines of pipes and hydrants will be sufficient.

The pipes laid last year for distributing the sewage were of Akron make with socket joints. The first pipes ordered were made with 3-inch sockets, but it was afterward found that sockets of ordinary depth would make a tight joint.

Before laying the pipes it was thought best to make a test as to whether weak or cracked pipe could be detected by ordinary inspection. An application of hydraulic pressure developed the fact that no inspection possible to apply could be relied upon. Many pipes that looked rough and full of fire cracks, that would ordinarily be rejected, were found to be among the best, while, on the other hand, the clearest ringing and best appearing pipes were often the poorest. These results made it necessary to apply the test generally.

The test applied was 20 pounds pressure per square inch.

It was soon found that this pressure would break too large a proportion—about two-fifths—of the 18 inch-pipe, so it was decided to lay the main in concrete without testing. The 9-inch pipes stood the test better, about one pipe in four being broken in the operation. This loss could be stood and still the sewer pipe be much the cheapest thing that could be used for the purpose.

It was a noticeable peculiarity of the pipes that 75 per cent. of those that failed broke below 10 pounds.

The bed of concrete around the 18-inch main was from 4 to 6 inches in thickness; the bottom generally made of Utica cement, mortar, and broken stone, while for the top and sides Portland cement was used.

The 9-inch pipes were laid with stiff Portland cement, mortar mixed with an equal quantity of sand.

A hemp gasket was tried at first, but it was soon found that the quickest and best way in every respect to make a joint, is to form a bed of mortar on the lower half of the socket and insert the next pipe, then with the trowel to apply the mortar to the annular space on the top, until it is forced through on to the inside. Out of 7,500 feet of pipe laid in this manner there has been found but one case of defective joints, and this was caused by a heavy rain during the laying.

The general conclusion from this experience thus far, in the use of clay sewer pipes, to carry fluids under pressure, is that for light pressures of about 10 pounds, the smaller sized pipes are well adapted to the purpose, if proper care is used in selecting them and in making the joints as they are laid.

I consider it by no means certain that sizes up to 18-inch cannot be profitably used, as I think that the lot of pipe of this size that we had was of rather poor quality.

Thin pipe seemed to give better results than thick ones.

The system of under drainage on 60 acres prepared last year, consists of one main under drain from six inches to twelve inches in diameter, of sewer pipe, laid north and south, and emptying into a ditch that discharges into Lake Calumet; and of parallel lines of common tile, 2 to 4 inches in diameter, laid to an average depth of 3½ feet, and an average distance of 40 feet apart. The tiles were laid with strips of tarred paper tied around the joints. Ten feet of tiles were strung on a pole at the side trench, the joints wrapped, and the whole ten feet put in place at one operation.

As to any of the general results of sewage farming, it is too soon to speak from experience upon the Pullman farm. The ground was covered with a tough sod, much of it a coarse wild grass, and was plowed late last fall. The sod is still so tough that it is impossible to put it in proper shape for irrigating the crops.

Then the spring has been so backward, owing to wet and cold, that no kind of crops are much advanced in this region.

Difficulty is also being experienced by the grass starting to grow upon the land where sewage has been applied during May.

It is intended to under-drain, 12½ feet apart, a portion of land best adapted to sewage purification, for filter beds—to be used as a safety valve, when, if applied to ordinary crops, sewage would be an incumbrance. Upon these filter beds some of the coarser kinds of crops can be grown.

As soon as the farm has really been fairly started—which, owing to the reasons given, cannot be before next year—I see no cause to doubt the success of the enterprise.

There is one feature of the system of direct pumping of the sewage at Pullman which may be of interest.

The pumps, screening tank, and pressure regulating valve are so arranged, and are so dependent one upon another, that notwithstanding the use of clay pipes for distributing the sewage, the workmen on the farm can control the quantity of sewage received with perfect safety. They can close and open hydrants to any desired extent, and vary the amount of sewage discharged almost as they please without danger or inconvenience. The operation is this: If the sewage is flowing at any given rate, and one or more outlets be closed, the effect is to partially close the pressure-regulating valve, by a slightly increased pressure on the distributing pipes, and to transmit from the valve through the force main an increased pressure to the pumps, which are provided with a steam regulator that reduces the pressure of steam admitted to the cylinders.

In order to avoid all possibility of injury to pipes or pumps in this operation, a stand-pipe with two overflows is provided at the pumps, as well as one at the regulating valve, so that there is an absolute guarantee against damage from the failure of any mechanical appliance.

The stand pipe connected with the pump main in the tower is—measuring from datum—54 feet high to the first overflow, and 90 feet high to the second overflow. These overflows are connected with a pipe which returns the sewage to the reservoir below the pumps. So that if every outlet is closed at the farm the pumps could continue to run with freedom.

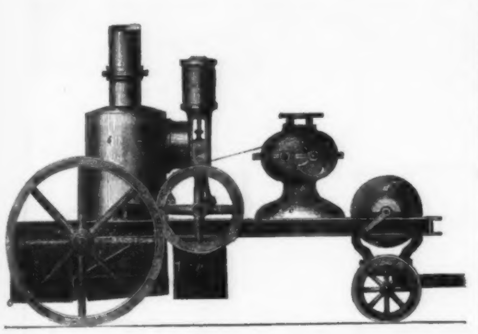
Should the pressure regulating valve fail to perform its functions, the overflow pipe will then protect the clay distributing pipes from undue pressure.

The general features of sewerage, and of sewage disposal adopted at Pullman, had the sanction of Mr. E. S. Chesbrough, who was consulted by the Pullman Company.

In carrying out the work I have been ably assisted by Mr. Edgar Williams, in the preparation of plans and the execution of the work at Pullman, and by Mr. E. T. Martin, in laying drainage and distributing pipes at the sewage farm.

SYLLWASCHY'S AIR BLAST FOR SWEEPING CHIMNEYS.

In countries and sections less favored than ours with anthracite coal, the great west and growing south for example, it is necessary to remove the soot from the chimneys at frequent intervals. To do this quickly and cheaply a German, named Otto Syllwaschy, has devised the apparatus shown in our cut. A steam boiler, *b*, is connected with a direct-action, 4-horse power engine, at *a*, from the fly-wheel of which a belt drives a Root's air blast, contained in *c*. The



blast is equal to driving twenty-four forge fires. A hose leads from *c* to the chimney, but when not in use is wound upon *d*; *e* is a receptacle for fuel, and *f* is the water tank. The cost for fuel is nine cents per hour, while the time required to clean a chimney is only twenty seconds. When the end of the hose has connected with the lowest opening of the chimney, air is blown in at the rate of 100 cubic meters per minute. A receptacle is put on top of the chimney to catch the soot and prevent its being blown around the city. The total cost of the machine is $1,400, but it works so rapidly that one is enough to keep all the chimneys clean in a city of 100,000 inhabitants. The apparatus can also be reversed so as to exhaust instead of blowing, and thus draw the soot out of any kind of fire-place or heating arrangement.

DUJARDIN'S CONTINUOUS PRESS FOR BEET PULP.

THE accompanying Figs. 1 and 2 represent a continuous press, recently exhibited by Mr. Dujardin, of Lille, at the Saint Quentin Exhibition.

The apparatus consists of two horizontal bronze cylinders, M and M¹, keyed to shafts, N and N¹, and arranged in a pressure chamber, mounted on a cast iron frame, F. The shaft, N, carries a gearing which is controlled by an endless screw, that receives its motion from pulleys and a belt. The shafts, N and N¹, are likewise provided with two pinions, that engage with each other, so that they revolve in opposite directions.

The cylinders are hollow, and their surface carries small circular grooves, which are very fine, and at the bottom of which there are apertures that open into the interior of the cylinders. Each of these latter is fitted with a filtering lining, consisting of a sheet of brass, 0·002 of a meter thick, perforated with a large number of small cylindro-conical holes, whose wide part is directed outwardly. The diameter of the cylindrical portion of these apertures is 0·0004 of a meter, and the apertures themselves are arranged quincuncially, and spaced 0·001 meter apart. The length of the cylindrical part of each aperture is about two-thirds of a millimeter.

In order that the iron plate of each cylinder may be easily replaced by another at small expense, in case of accident, it is divided into four parts, which, being juxtaposed, form a continuous surface.

The small size of the orifices in the filtering surface prevents the passage of the finest solid substances, and insures of an almost complete elimination of the soft pulp.

The frame, F, is provided with a conduit, A, which bifurcates at E and E¹, and through which flows the juice forced in by the pump. The force-pipe of the pump is coupled with the press through the tubulure, A, which is provided with a penstock, B, whose slide valve, C, may be raised by means of a screw, D. The two heads, G, of the apparatus, are bolted to the bedplate of the frame, and form, with the shells, H and I, the walls of the compression chamber. Two strips of leather, L and L¹, whose free extremities bear against the cylinders and form a joint, are attached to the extremity of the shells by an iron band. To the heads, G, there is affixed a piece, P, whose distance from the surface of the cylinder, M, is regulated by means of the screws, R and R¹. It is through the space left free between this piece and the cylinder, that the pulp, after being rolled between the two cylinders, escapes progressively, and runs along the apron, S. The pulp carried along by the cylinder, M¹, is detached by an iron blade, Q, which is placed at a short distance from the filtering surface. The juice enters the cylinders, and from thence runs into a gutter, T, after traversing the orifices in the heads, G.

is the mean composition of the pulp after the first and second pressing:

Water	80·00	79·00
Sugar	4·45	2·18
Ashes	1·45	1·25
Vegetable matter	14·10	17·62
Pulp per cent. of beets	23·25	22·60
Sugar lost per cent. of beets	1·034	0·481

Thus, with a single pressing, the loss of sugar per 100 kilos of beets would be 1·034 kilos; but, thanks to mixing and repressing, this loss is reduced to 0·481.

The proportion in sugar in pulps of the first pressing varies from 6·5 to 7·5, and that of pulps of the second pressing, from 3 to 3·75 per cent.

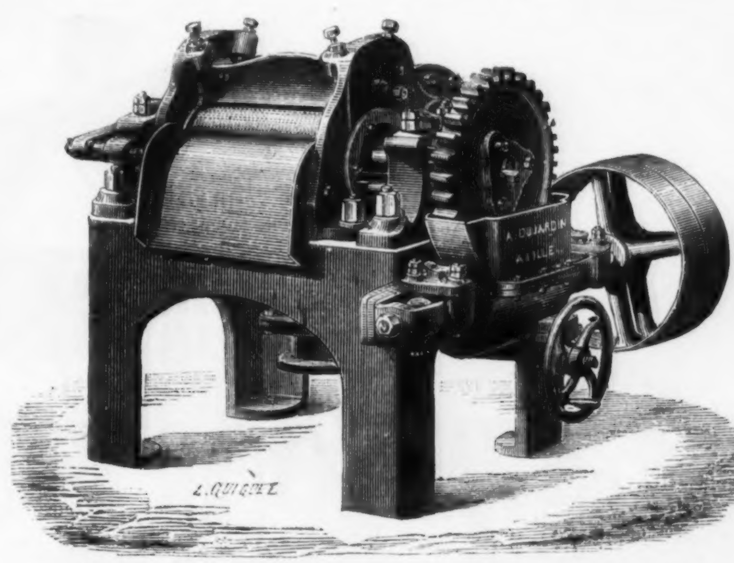


FIG. 1.—CONTINUOUS PRESS FOR BEET PULP.

The role of the compressing chamber is very important, and partly constitutes the superiority of the Dujardin press. It produces, in fact, a strong and continuous pressure of the pulp, whatever be the nature of the latter.

Again, we must point out as another peculiarity, the special joint that has been devised for keeping the space between the heads and the extremities of the cylinders tight without having recourse to leather, or those other packings that always produce perceptible friction. On the surface of the cylinders there are circular grooves, and opposite these there are corresponding projecting rings set into the heads. These rings allow between the grooves a certain play which the pulp fills up, and, in which, so to speak, it becomes felted.

There is thus obtained a very regular pressure over all the points of the surface of the cylinders, so that the pulp spreads in a uniform layer, which presents the same thickness and the same degree of dryness.

With a velocity of seven revolutions per minute of the cylinders, the press treats 40,000 kilogrammes of beets per day of 24 hours.

At Messrs. Mortagne & Co.'s sugar works, at Flaucourt, there are treated from 225,000 to 230,000 kilos of beets per day, with five of the Dujardin presses on the first pressing, and four on repressing. The production of juice averages 2,800 hectoliters. The proportion of pulp obtained is from 23 to 24 per cent. of the weight of the beets. The following

In 1880–81, an average of more than 150 analyses showed a loss of sugar after the second pressure of 0·53 to 0·65 kilo per 100 kilos of beets.

At the works of Messrs. Georges, Cornaille, Daillié & Co., which use four presses for first pressing and four for the second, there are treated per day of 20 hours, 2,000 hectoliters of juice at a mean density of 3·7°.

About 77 kilos of beets produce a hectoliter of juice at 3·7°, that is to say, that, per hour, the presses crush 7,700 kilos of beets.

The juice coming from the presses at the first operation has an average density of 4·2°, which descends to 3·7° by the addition of the juice of the second pressing, one-third of which is added directly, one-third goes to the rasps (sulphurous acid being added to it by passage through a Vivian & Messian apparatus), and the remaining third serves to dilute the lime. The mean density of this last named juice is 1·2°.

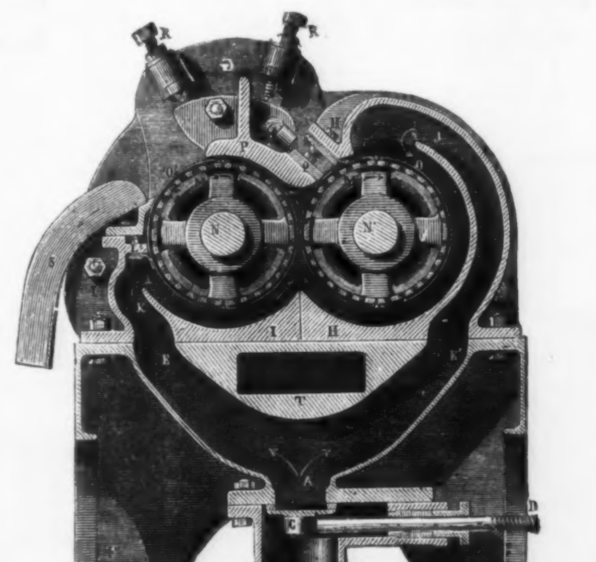


FIG. 2.—VERTICAL SECTION OF THE PRESS.

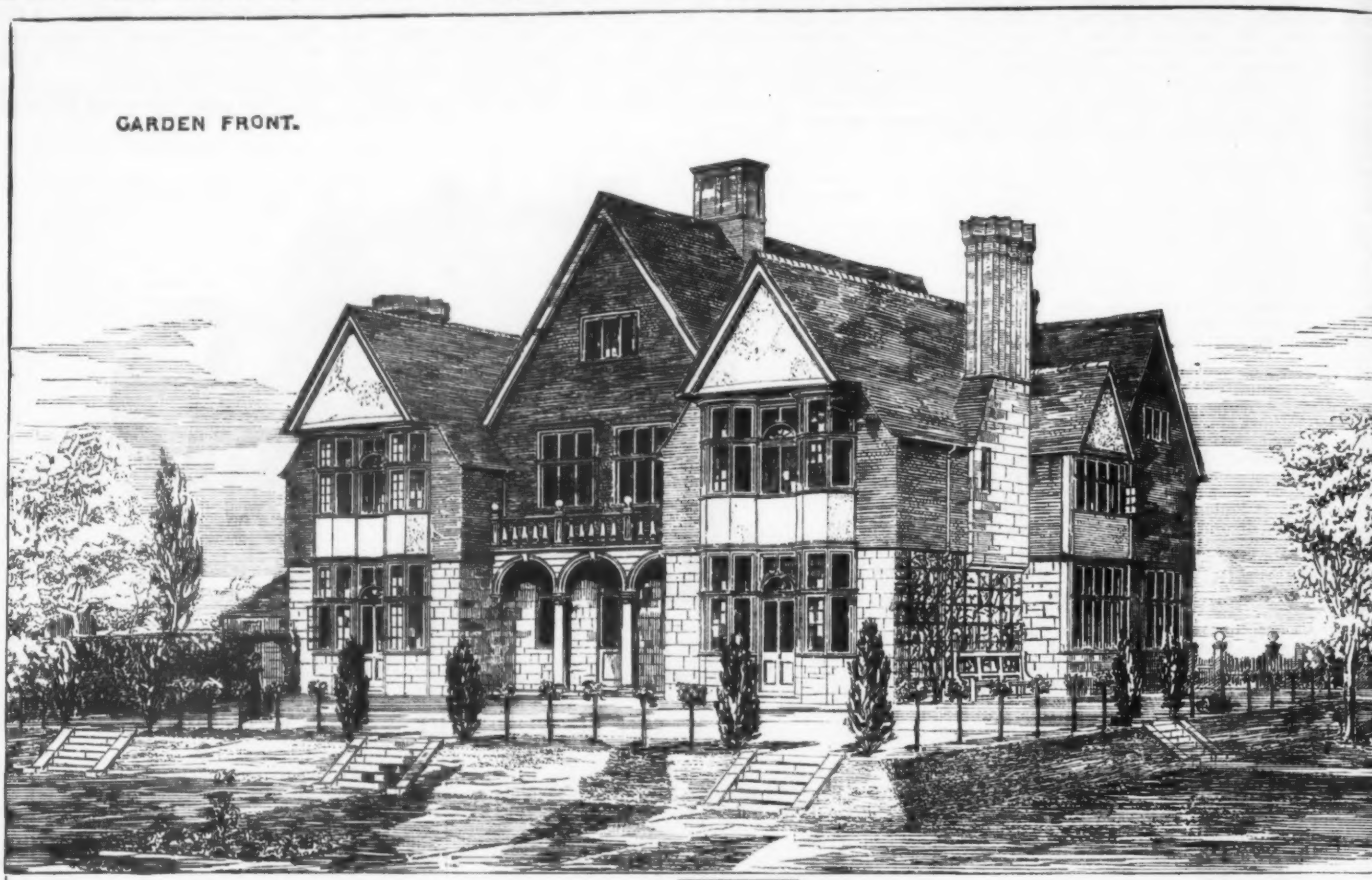
The yield in boiled mass, per 100 kilos of beets, is 6·6 liters in volume, and the yield of No. 3 extra sugar, per hectoliter of such mass, is 69 kilogrammes.

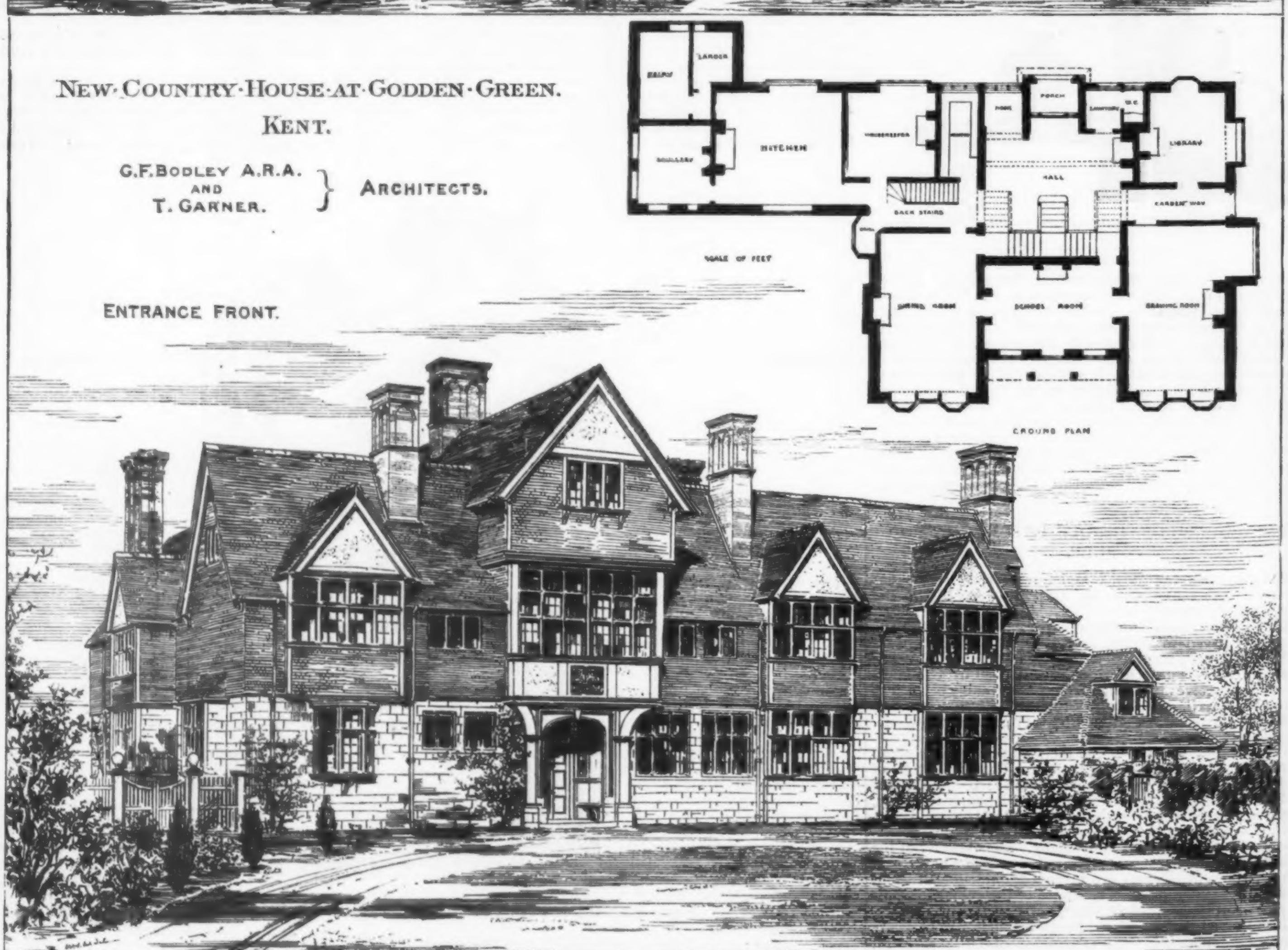
Supposing that the quantity of pulp be 22·35 per cent. of the beets treated, we arrive at a loss in sugar of 0·81 kilo per 100 kilos of beets.

These figures deserve to attract the attention of manufacturers, and we need no longer dwell upon the advantages that this apparatus offers them.

HOUSE AT GODDEN GREEN.

ONE of our plates furnishes two views, as well as a plan of a new country house now in course of erection at Godden Green, Kent, from the designs of Messrs. G. F. Bodley, A.R.A., and T. Garner, joint architects. The plan at once explains the distribution of the building, and shows how admirably the requirements of a moderately-sized country residence may be arranged without effort or straining after effect. The porch is central, and leads to a handsomely proportioned hall, with a double-flighted staircase, forming an important feature in front of the entrance doorway. The dining-room and drawing-room occupy the main corners of the block on either hand, with a large schoolroom between, having doors which give a continuous communication.—*Building News.*





ORNAMENTAL TURNING.

By J. H. EVANS.

I ILLUSTRATE and describe an ornament which contains a great variety of patterns, and although nothing out of the way in the form of apparatus will be required to do it, it will require a certain amount of experience in the use of those tools, cutters, etc., required to be used, and also a very considerable amount of patience.

It would be seen at once, could the original be viewed by all, that it is composed of African black-wood and ivory, the contrast being extremely effective. As in all cases I should advise beginning at the base, therefore the four feet will be the first thing to do. These are simply plain, without the slightest ornament or cutting about them. Having made them all exactly alike, which will require a deal of care, the stand, which is oblong, will be the next part to proceed with. This is $4\frac{1}{2}$ inches long, by $2\frac{1}{4}$ wide, and 1 inch deep. Although such a piece of wood does not seem much to look at, or appear difficult to produce, it is not at all an easy matter to do it. It will be seen that on the top edge a moulding is cut, all the miters of which are brought up perfectly sharp, and I may mention that, unless all the edges of such a piece of work are made so, the beauty of the work is entirely gone.

Having now explained what it is, I will set about explaining the best way of doing it. In the first place, it is better to rough out the piece of wood somewhat near the shape required, leaving, of course, enough material to finish it up. This done, hold it in a universal chuck, and, in the under side, screw it to fit the nose of the mandrel, and then place it upon the dome chuck. If necessary to be raised further

from the wheel, a nose chuck may intervene between the work and chuck. With regard to the dome chuck, I am now making them somewhat differently, inasmuch as the arm which carries the wheel is lengthened, to allow of larger work being cut in it. There is no reason why it should not be so made, and it is quite clear that the extra length does not in any way interfere with the working of it, except that it adds to its capabilities, which must be an advantage. The work being chucked, the slide-rest must be set quite true to the surface, and with the eccentric cutter, having the tool extended to cut a circle of about 1¼ inches, the first side may be cut. This is a case in which the segment apparatus previously described will be found of very great advantage, as it holds the work perfectly rigid, which is a very important matter. Having cut one side, it is better to take one half-turn of the tangent-wheel of the dome-chuck, and cut the opposite side. This done, the slide rest must be moved back, and, by moving the wheel one quarter, the position for the next face will be obtained; and, when cut, the half-turn again taken to bring the corresponding side to its place. The wheel having now been moved, and a face cut at each fourth, with care and a sharp tool in the eccentric cutter, about No. 20 wide, these faces may be cut perfectly smooth. We now come to the moulding round the top edge. To cut this, place in the tool box of the slide-rest a universal cutter with a moulding tool fixed. The precise radius is of no moment, as it cuts clean through. It will now be obvious that the cutter would cut the moulding exactly in the center of the face of the wood, and, in order to bring the edge of the wood to its proper place, where the moulding is required, the screw of the dome-chuck must be moved, to lower the arm which carries the work. The dome-chuck should be fixed in a vertical position, which can be very easily done, especially by aid of the segment apparatus. When the work is set in position, and the tool to the center, the two sides and ends may be cut, great care being taken when passing over the corners to avoid chipping—in the event of which happening the whole thing, so far, is at an end, and must, of necessity, be gone over again. We will assume, however, that, so far, all has been successful, and will proceed with the lower piece of the ivory pillar.

CANDELABRUM IN BLACK-WOOD AND IVORY.

This, it will be seen, is also cut in the form of a hexagon at the base, and to such a size that across the flat it is exactly the same as the top of the black wood upon which it rests. In cutting the semicircular flutes seen on each of the curves, there are two or three different ways to accomplish the same. First of all, the bare form must be cut, and this may be done with a long circular cutter, about ⅛ inch in diameter, running in a universal or horizontal cutting-frame in the spherical slide-rest. Or another way to get over it, if the spherical slide-rest is not at hand, will be to have a horizontal cutter with a vertical movement. With this little difficulty will arise; in fact, it was with such a tool that the present specimen was done. Having set the tool to the center, also to the radius of the curve, the six plain facets should be cut, the cutter being driven at a high speed, the vertical movement being taken each side of the center, till the corners are all cut up sharp. This done, set the vertical slide, for such it really is, to the center with a round-nose tool, and cut the first flute. Take this round to each side by shifting the under peg, and then raise the tool by means of the slide, and cut three cuts each side. The tool should be kept with a very keen cutting edge, and then each cut will have a high polish when finished; this is one of the most important things in ornamental turning. The six sides to form the hexagon can be cut by simply setting the radius of the eccentric to cut sufficiently large to bring up the corners, and move the slide-rest the length desired to complete the form.

On the top of the curve will be seen another thin piece turned to a curve. This being turned, is fitted on to a boxwood chuck, and then cut into the shape seen by the aid of the eccentric cutter and drill, the eight points being brought up by cutting a corresponding number of circles, and adjusting the radius of eccentric cutter to bring the points up sharp. This done, the smaller hole is pierced through with a drill. Following this is the pillar, which is turned taper and cut with a basket pattern. The present was cut of a coarse pattern to give effect, and has in it one hundred and four consecutive cuts. The tool being No. 10, ten-hundredths wide, it was, of course, equal to one turn of the slide-rest screw; and if the rest is set at zero when starting, particular attention being paid that there is no loss of time in the slide-rest, or, at all events, that it is taken up, which is easily done by moving the rest either always in the same direction, or, if not, move it either way sufficiently to be sure that the tool-box is moved, and not the screw only. To cut the pattern as seen, set the radius of cutter; see, as I say, that the reader on slide-rest screw is at zero, and cut, dividing the division-plate into four only, 96, 24, 48, 72. This is, of course, for the 96; any other may be used. The first cut will be according to these settings. This done, move the slide-rest one turn, and set the index-peg so that the next cut begins at 12, 36, 60, 84. These different divisions must be used alternately, which will bring each series of four cuts, with their points, in the center of those previously cut; and when cut clear, with a sharp tool, it is one of the most effective patterns. There are a number of different ways of cutting what is termed the basket pattern. By altering the number of divisions between each series of cuts a spiral line of points will be the result, all equally effective in appearance. On the top of this pillar a corresponding piece to that on the top of the lower curve is cut and executed in exactly the same way.

We now come to the body, which is made of African black-wood, and, as will be seen, covered with ivory cut very thin. This center part forms a box to hold stamps, etc. Having turned it to the form required, a thin coating of ivory must be accurately fitted to it, and the latter then transferred to a boxwood form of exactly the same shape, and well fitted, and then held to the boxwood chuck by some very thin glue, and, when dry, proceed to turn, keeping, of course, the slide-rest set to the same angle as when turning the black-wood; and here, in cutting the ivory, we come to a basket pattern as before described, forming, as seen, a spiral line only cut through in order to show the black-wood. This cutting through could not, as a matter of course, be done unless the boxwood fitted the ivory well all over, so as to support the latter, as it will be seen there is very little substance left. The ivory being turned, there will be no necessity to go to the trouble of highly polishing the outer surface, as it is cut up sharp all over; but it may be cut without. Place the vertical cutter, or the universal, whichever is to be used, in the slide-rest, and in it a cutter, No. 8. Set the division-plate at the 96 division and cut round. Bring up the point sharp, taking eight divisions at each cut, leaving twelve points. Now take one division forward and cut round at each succeeding eighth hole. Advance one hole again, and proceed as before, advancing one hole for each succeeding series of cuts, all being cut at every eighth. After the one hole has been taken for each adjustment, there are thirty-five consecutive series of twelve, making five hundred cuts in this one piece alone, every one of which must be very carefully done, simply because if one is hastily done and allowed to break away, the whole piece will be valueless, and this, I need scarcely say, is exceedingly annoying, more especially if it happens when the work is nearly finished. When cut, the boxwood must be placed in warm water, not boiling, in order to soften the glue and allow the ivory to come off. The chuck being taper, little difficulty will be found in removing it.

We now pass on to the pointed fringe, we may call it, that hangs down from the bottom of the body; this is made from a circular piece of ivory turned to fit the bottom of the black-wood; it is five-eighths deep, and is cut out with the eccentric cutter and drill. First turn the ivory inside and then place it on boxwood, the same as in the previous case, and glue it on; then turn the outer surface, and if, when the part is turned that fits on to the chuck, the slide-rest is set to the stop, and the tool then set back to whatever thickness is required—for this a full thirty-second—there will be no fear of turning it through, which is done in many cases in the endeavor to get it too thin. This piece, when turned, should be highly polished, as some parts of the surface are left uncut. To begin cutting out this pattern, it is always better to cut the largest hole first—that which forms the points. In this case there are sixteen, consequently sixteen holes have to be made, and the eccentric cutter may be used in place of large drill, the radius being adjusted to the required size. Having cut the first row of holes, the slide-rest must be moved sufficiently to allow the next cut to pass into the hole previously made; the same number being cut, the drilling instrument must now take the place of the eccentric cutter, and a drill placed in it, the size 24, and the rest again moved, so that nearly half the hole is cut into the second one, leaving only the full half. This completes the first part. It will now be observed that in the center of each part left another hole, No. 12, is drilled, and then with a smaller drill, a groove is cut through the ivory from one hole to the other, and so completes this part.

On the top of the body a ring of ivory is fitted, with a very thin projection, which is cut out in the first place with a drill, No. 20, which, having been inserted thirty times, leaves sufficient space for a small drill. No. 6 is used at the extremity of each part so left; at the top of this another hole is drilled, which finishes off the effect given to it. I may mention, as a matter of fact, that it is almost impossible to convey the exact appearance of the original by engraving, unless very great time and expense are devoted to it. We will proceed to the top or cover of the body, which is made of black-wood, the same as the bottom. Having fitted it, it should be chucked by the latter fitting, and turned to the curve desired; a piece of ivory must then be fitted accurately; the ivory then transferred to a counterpart of boxwood, and treated as all other such work, viz., glued. And here, again, I will call attention to the necessity of seeing

SUGGESTIONS IN DECORATIVE ART.—ORNAMENTS ETCHED ON ARMS AND UTENSILS, BAVARIAN NATIONAL MUSEUM, MUNICH.—*From The Workshop.*

that all parts of the ivory touch the boxwood chuck, as it will be seen the ivory that is left after it has been cut is extremely delicate. In cutting such a piece as this, it would look like requiring a spherical slide-rest; but not so. The curve can be turned carefully by hand, and the surface highly polished; then the slide-rest can be set to an angle, and the center of the drill brought as near that of the part to be drilled. The first cuts will be those that form the points, fifteen in number; and follow on with a series of six drills, all gradually decreasing in size, which necessitates ninety cuts in this piece; following this is the ivory slip which goes above it, containing thirty-two holes in all, eight in circumference and four in length; on the top of this is a very delicate kind of star, curved both sides, and cut out to eight points. This is a very delicate piece of work, and will require more care in chucking really than in cutting. The extreme top is turned by hand, and then cut with a drill; and in the center of the ball a small bead drill is inserted four times. On the bottom of the lid a somewhat deeper piece of ivory is made to fit and curved over, being then cut into eight different points in the first instance, the center of each remaining portion being again cut out, forming in reality sixteen points in all. This lightens the appearance very much.

So far, then, the base, stem, and box are completed, and we must now go on to fit up the arm which carries the candle-sockets. In order to get them exactly opposite each other, place the black-wood on a chuck, and with the drilling instrument drill a hole each side. If the drill is adjusted to the exact length of the lathe centers, as it should be, the holes must be perfectly true, the arms extended are, as will be at once seen, quite plain. On the end of each a socket is fitted, being first turned in plain form precisely alike, the points turning downward being separate pieces. When bored out to receive the candles, they should be chucked by that hole, each one on a separate boxwood chuck, identical in length, and to cut the pattern seen on the bottom, the eccentric cutter is the instrument with a left side-cutter single angle of 45°, thirty cuts, the slide-rest being set about three-sixteenths below the center of the lathe; having cut one, place the other on the nose of the mandrel, and the chuck being the same length, and the same settings used, they must both be precisely alike. I may say that this is really the only way that I can recommend to facilitate making any number of things alike, as the same setting can be used without any readjustment of the slide-rest.

In cutting the fringes, so to speak, for the top of these sockets extreme care must be used, as they are the most delicate parts about it; two pieces of ivory must be turned out, one and one sixteenth diameter, to fit over the top of the socket, and as will be seen, a very thin projection left to rest upon the top of the same, the two pieces being turned to the same size; place the same upon two separate boxwood chucks and glue them; when set, turn them each as thin as possible, and slightly taper off the extreme edge, so that the points left will be quite sharp. This done, set the slide-rest quite true to the cylinder, and with a No. 12 bead tool the first series of twenty-four holes may be drilled. The reason why I say use a bead tool is that it has less to cut out, and renders less chance of breaking away; when this row of holes is completed, shift the slide-rest, or rather the drill, so that when the next hole is drilled a kind of square is formed at the part left uncut; the division-plate must now be set to the center of the part left, and another hole drilled at the top. When both these pieces are finished and are exactly alike, which they must be, the slide-rest must be set round to the surface, and with a small drill, No. 8, forty-eight holes are again cut, leaving the same number of points. This will be found exceedingly delicate; but as it is only to keep it resting on the top of the socket it is quite strong enough for the purpose; these two pieces will be found, perhaps, the most difficult part of this specimen; when accomplished, however, it is a most elegant finish. We now come to the stems in which the candles actually go. It will be seen that they are made of black-wood, with ivory over them, 1½ inches long and ½ inch in diameter, and highly polished. The ivory is turned in the form of a cylinder, and then fitted to a counterpart of boxwood in a similar manner to the other parts turned to the thickness required, and then cut with the vertical cutter in the same way as the body, only a lesser number, viz., four strands (we may call them) cut with a tool not so wide as the larger pattern. To complete its length twenty-five cuts are taken; thus the division-plate divided into four, cut round, move one hole forward, adjust slide-rest exact width of tool, cut round again at every quarter of the pulley; proceed in the same way till the length required is cut. When finished it will be found a somewhat difficult matter to get the ivory off the chuck, for two reasons: first, the ivory that is left is so extremely delicate, and secondly, the wood upon which it fits being a cylinder, the wood swells with the immersion in hot water, and so fixes. In doing this specimen I broke several before getting two perfect ones. At the top of this part it will be seen there are two more pieces turned to a curve fixed in the same way, and cut out with a drill, which, being used in the same way as before described, forms a kind of star pattern, twelve points in the first and eight in that piece which fits on to the bottom of the candle.

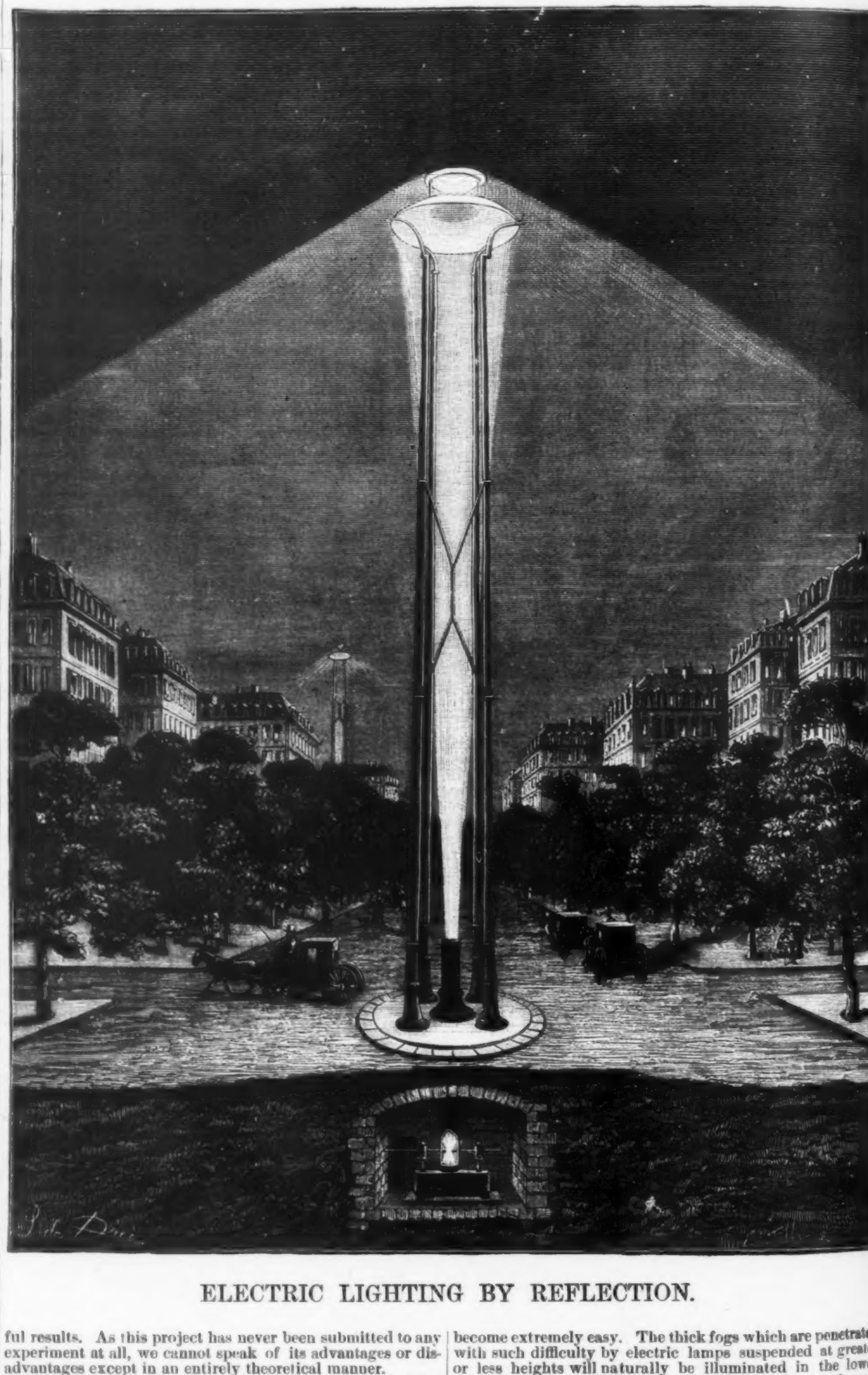
The chains are composed of separate links, each alternate one being split. This done, those that are split may be either put in the mouth or warm water; they will then open freely without splitting. The quickest way to make a chain of this kind is to hold a piece of ivory in a die-chuck, and bore it up the size required; then turn it into a long cylinder and cut off the rings with a sharp, narrow parting-tool.—*Eng. Mechanic.*

A PRACTICABLE SELENIUM PHOTOMETER.

It is stated that a working selenium photometer has been constructed by Messrs. Siemens & Halske, thus utilizing the well-known property possessed by selenium of varying in electrical conductivity with the amount of light falling upon it. The arrangement consists of a Thomson reflecting galvanometer, receiving light from a lamp at right angles to it, and reflecting the spot of light upon the scale in front. The selenium cell is attached to a blackened tube 3 millimeters in diameter and 15 millimeters long, mounted horizontally on a vertical rod. The same stand that carries the rod is fitted with a graduated bar in the line of the axis of the blackened tube; and a standard candle holder is made to slide along the bar, in the focus, so to speak, of the tube and its cell. The cell is connected in an electrical circuit with a battery and the galvanometer already mentioned; and the spot of light on the scale of the latter is regulated to stand at zero when the selenium cell is kept dark. When it is desired to measure the brilliancy of a light at a known distance, its rays are allowed to reach the selenium, by removing a shutter which protects the latter; and the degree of lessened electrical resistance is thereupon marked by the spot of light on the galvanometer scale. This having been recorded, an equal deflection is sought for by the aid of the standard candle, which is moved backward and forward along the graduated bar for this purpose. The object having been attained, the distances from the cell of the candle and the light to be measured are compared, and the comparative illuminating power of the latter is thus obtained.

PARTZ'S SYSTEM OF ELECTRIC LIGHTING BY REFLECTION.

Mr. Partz exhibited at the Palais de l'Industrie last year, in the American section, a new plan of lighting streets and other public places, which attracted the attention of numerous visitors by reason of the originality of the combination that it represented. But the inventor's project does not, properly speaking, constitute a new system, for it is only an application of the powerful luminous foci that electricity is now capable of producing, made under very peculiar conditions, and which must, in our opinion, give very doubtful results. As this project has never been submitted to any experiment at all, we cannot speak of its advantages or disadvantages except in an entirely theoretical manner.



ELECTRIC LIGHTING BY REFLECTION.

It has seemed to us that we would interest our readers, however, if we explained to them the arrangements devised by Mr. Partz, and gave them a perspective view of a portion of a city lighted by large electric foci placed beneath the level of the ground, and the light from which is widely diffused by reflectors at a high elevation.

As may be seen in the accompanying engraving, which represents at the lower part a section of the roadway of a wide avenue, there is located underground, in a structure built for the purpose, an electric regulator whose rays, thrown upward by a projector, traverse an enameled cylinder about three meters in height. The luminous fascicle which emerges from this latter forms a very elongated inverted cone as it shoots upward, and strikes the surface of a reflector placed at a height of forty or fifty meters, from whence the rays are diffused over the area that it is a question of lighting. According to the extent and arrangement of the place, the curves of the reflector must be more or less pronounced, and traced according to laws determined by the theories of optics, account being taken, of course, of the modifications that experience may indicate.

The iron frame designed for supporting the reflector at its apex will have to be as light as possible so as to be elegant and not to obstruct the street, and yet be capable of resisting gusts of wind which would exert a great pressure against an apparatus located at so great a height.

We leave to the inventor the responsibility of the following advantages to be derived from this new mode of lighting cities:

According to him, we may employ with his combination very large electric foci, while at the same time avoiding the inevitable loss that results from the more or less multiplied division of the current. The light is evenly diffused, and in spite of the enormous power of the initial focus, the eye runs no risk of being injured by its dazzling brilliancy, since the producing apparatus is completely hidden. The loss of light through reflection is less than that resulting from the use of translucent globes The electric apparatus is always accessible, and its maneuver, regulation, and surveillance become extremely easy. The thick fogs which are penetrated with such difficulty by electric lamps suspended at greater or less heights will naturally be illuminated in the lower portions by the enormous luminous fascicle shooting up from the ground.

We have numerous exceptions to take to these allegations of the inventor, and Mr. Partz will himself understand all the importance of them when his system, until now purely theoretical, shall have been put in practice. We shall wait till that time to discuss more seriously a project which is not wanting in a certain originality, and the realization of which in an elegant city like Paris would produce the most brilliant and picturesque effects—*La Lumière Electrique.*

The Electric Light as a Moth Catcher.—Dr. I. E. Nagle, of Vicksburg, Miss., suggests the use of uncovered electric lights for killing the moths, *Aletia*, from whose eggs the destructive cotton worm is hatched. He believes that a few lamps properly placed would attract and destroy the moths, so as to protect a wide belt of cotton country. The plan would be well worth trying wherever electric lamps are in use.

AN ELECTRIC BATTERY OF FLAMES.

THE electrical properties of flames have lately been investigated by Dr. Julius Elster and Herr Hans Geitel with curious results, which are stated in the *Annalen der Physik und Chemie*. It has long been known that flames possess electrical properties, but the character and effect of these were obscure. The present investigation has been conducted with very delicate instruments and with great care. The gas-burner used for this purpose was specially constructed of hard glass tubing, 4 millimeters in diameter, and was perfectly insulated. It was found, among other things, that as long as a metallic electrode is outside the flame and another inside, the outside one is positive and the inside one negative. The film of hot air outside the flame is always electrically positive, and the flame inside relatively negative. The same result is obtained with flames of spirit lamps, and with ordinary gas and candle flames. More curious still, when air was made to burn with a flame in an atmosphere of coal gas, the same phenomenon was observed; the hot coal gas being positive relatively to the air flame. All these flames showed a potential varying from about 1¼ to 1¾ times that of a Daniell's cell. Moreover, when wires of other metals were used, the differences of potential were not the same as before. While the lower electrode in the base of the flame remained of platinum, the upper electrode was changed to copper wire, when the potential rose to 2 Daniell's cells. With aluminum it was equal to 3, and with a lump of clean sodium the potential even rose to 5 times that of a Daniell's cell. Messrs. Elster and Geitel succeeded in arranging a flame battery of 25 spirit lamps, by the device of causing a curved piece of platinum wire to lead from the base of one flame to the tip of the next, and another piece of wire from the base of this to the tip of the succeeding one, and so on. This "flame-battery" had a potential 25 times as great as that of one flame; but it would not yield much current, owing to the enormous internal resistance of the flames themselves. The experimenters conclude that electrification by flames is independent of the size of the flames; that it is dependent on the nature and state of surface of the electrodes; that it is also dependent on the nature of the gases that are burning in the flame; and also dependent on the state of ignition of the electrodes.

CLAMOND'S INCANDESCENT GAS LAMP.

ONE of the most interesting incidents of the recent congress of the Société Technique de l'Industrie du Gaz en France, at Paris, was the account of M. Clamond's incandescent gas lamp, given by M. Servier, and the exhibition of the apparatus which followed. We shall now give a transcription of so much of the paper as will be of interest to our English readers, together with a diagram of this ingenious apparatus. M. Servier begins by asserting that the introduction of M. Clamond's lamp will be the occasion of a revolution in the methods for the utilization of gas for lighting. Since the days of Philippe Lebon, the prototype of French gas engineers, the use of gas for lighting has been always imperfectly managed; while it is only since 1859 that the best methods of consuming gas in ordinary burners have been known. It was then that the labors of MM. Audouin and Bérard, under the direction of MM. Dumas and Regnault, established the laws of the utilization of illuminating power in burners. It is but recently that the well known fact that the luminous intensity of a body in the state of ignition increases in a more rapid ratio than the rise of temperature, has been applied—notably by Herr F. Siemens, in his regenerative burners. But it has also been known that the amount of heat developed by the combustion of gas is quite disproportionate to the small quantity of hydrocarbon contained in it, and which is susceptible of being decomposed into solid carbon, which alone is capable of affording light when raised to a high temperature. It has also been proved that gas, when transformed into motive power, for the production of electric light, develops in powerful arcs a quantity of light exceeding that of its direct combustion, notwithstanding all the losses due to the conversion of its heat into motive power and electricity, and then into heat and light. It follows from these facts that there is a possibility of obtaining more light from gas by employing it as a heating agent than in burning it directly. This is the result obtained by M. Clamond with his new lamp.

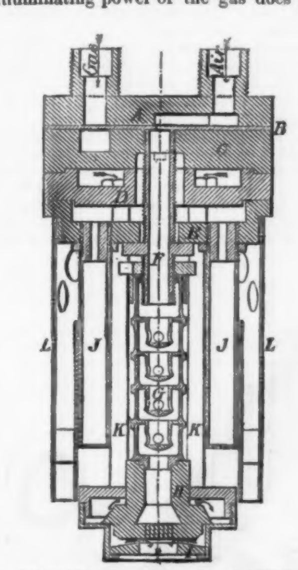
The well known Drummond (or lime) light, which has been subject to numerous transformations, reappeared in 1867, under the name of the oxyhydric light, when M. Tessié du Motay had found a relatively cheap method of making oxygen. The essential conditions of success were, however, wanting. It was required to produce a new gas, and to distribute it in quantities far more considerable than for lighting gas, and of greater density; so that the work of distribution became practically impossible, or at least very costly. The pencils of magnesia or zirconium, which formed the incandescent portion of the light, constituted an element of complication incompatible with the practical use of an artificial light. M. Clamond's lamp is nothing more than the Drummond light made practicable. His invention is characterized by two essential points—first, the substitution of oxygen by air; secondly, the substitution of a magnesia wick for the pencil of zirconium or magnesia.

Air may replace oxygen in almost all its applications, on condition that it shall be previously heated. It is therefore by heating the air employed that M. Clamond has been able to obtain an effect equal to that of oxygen in the Drummond light. But it is not easy to bring to a high temperature, and in a short course, a quantity of air six times greater than that of the gas to be burned, because the velocity of air must be very great, and it is moreover a very bad conductor of heat. M. Clamond has been able to do this, in a manner to be described further on, by bringing every part of a current of air into contact, through ceaseless eddyings, with the surface of a small tube of refractory earthenware, heated from without. Such an effect can only be produced with a loss of velocity necessitating an initial pressure; and this pressure was a short time since carried to 200 mm. of water, but by improved apparatus it has now been reduced to 35 mm. at the inlet of the lamp. It is therefore only a small power that is required to drive the air forward under such a very small pressure, yet some power is needed, and so is a special distributing plant to bring the air to the lamps. This is an inconvenience, it is admitted; but it should not be exaggerated. M. Servier says that gas engineers especially should not complain of having to lay pipes for air, when they must admit the necessity of pipes for gas.

The magnesia wick is a happy idea of M. Clamond. It is a small conical basket, made of a kind of lacework of spun magnesia. The magnesia in powder is made plastic with a solution of acetate of magnesia, and then worked like vermicelli into threads, of which a netted mesh is made. These meshes facilitate the intimate mixture of gas and hot air at the burner, and the tissue of magnesia is also brought to incandescence. It is this basket of magnesia, or wick, which produces the light; and the light is perfectly fixed, because it is emitted by a solid body and not by a flame, as in the ordinary combustion of gas. The quality of the light is described as remarkable; it is of a warm yellowish tone, like daylight rather than moonlight. The baskets of magnesia, which are of insignificant cost, and which are here called the wicks of the lamp, should be changed every eight days, or after forty hours' continuous use. They will last longer, but only at the expense of the light, which would finish by assuming a bluish cast. This result is partly in consequence of a molecular change in the magnesia after having been kept incandescent during a certain time; and also because of a diminution in the thickness of the threads, in consequence of a waste of material in the form of fine dust. This circumstance does not present any other inconvenience, because the dust is white, and does not stain objects upon which it falls; and is moreover insoluble in acids, and has therefore lost its laxative properties. The renewal of the wicks is a very simple process. The wicks are delivered in paper cases, to avoid risk of breakage by the fingers, and the whole is fixed in a bayonet socket provided with two platinum wires for sustaining the magnesia.

The lamp to be described burns with the wick downward, in order to avoid the shadow of the apparatus; but this is not essential. Its brilliance may be varied at will by means of a cock. M. Servier has himself verified the results announced by the inventor, as regards gas consumption and power of the light. Only two models have yet been made. The first, burning 180 liters (6·35 cubic feet) of gas per hour, gave an illuminating power of 4·15 Carcels, or 39·425 candles; and the second, burning 500 liters (17·6 cubic feet) of gas per hour, gave an illuminating power of 18 Carcels, or 171 candles. The duty of the gas in the first example is therefore 6·208 candles per cubic foot; and in the second it is 9·72 candles per cubic foot.

There is thus, by the employment of M. Clamond's lamp, a possibility of securing considerable economy over the ordinary burners, and even over those of high power at present known. But besides this, and by way of justifying the word "revolutionary," which he had used to describe the principle of this new burner, M. Servier points out that the intrinsic illuminating power of the gas does not play any



INCANDESCENT GAS LIGHT.

direct part in the production of the light, but the heating power is alone utilized. It is therefore evident, if the use of the burner should become general, that it would be useless to specially regard the illuminating power of gas to be employed for lighting. It is not necessary to follow M. Servier through the various imaginings which this idea suggests to him, foremost among them being the utilization of inferior coals and water gas for lighting purposes. He recommends gas companies to take the burner under their protection, in order that its future development may be in accordance with their own requirements. As the public are dreaming of nothing else but lighting by incandescence, by the aid of electricity, so M. Clamond's burner provides a means of incandescent lighting with the assistance of gas.

The general construction of the burner is represented in the accompanying figure, which shows the burner in longitudinal section. The air arriving under pressure at the right-hand opening in the top plate, A, and the gas at the other orifice, passing through nipples in the copper plate, B, are received in the distributer, C. This distributer is a plate, pierced with holes of determinate size and number, to pass the respective quantities of air and gas, which constitute three distinct supplies. The first of these is a mixture of air and gas which goes to feed the burner; the second is a mixture of gas and air for the supply of the auxiliary burners; and the third is the central air supply, which goes direct to the burner through the heating pipe. Returning, for the sake of clearness, to the course of these several supplies, taken separately, it has been observed that the gas, regulated by a rheometer, comes through the left-hand opening, and is divided into two portions by a peculiar channel in C. Of the total quantity, eight-tenths goes through a groove in D to be mixed with a portion of the air supply. Thence the mixture passes to E, where it enters the pipes, K, which conduct it to the base, I, where it is burned.

The burner proper is therefore supplied with a combustible formed of eight-tenths of the total quantity of gas supplied to the apparatus, mixed with air. The remaining two-tenths of the gas diffuses under the distributer, in a groove in the block, D, and goes to mix with a regulated proportion of air. This second mixture is taken through D to the hollow piece, E, where begins the connection with the hanging tubes, J, pierced at their lower extremity with holes that direct a flame against the side of the heating tube, G. These are the so-called auxiliary burners.

Finally, the remainder of the air is taken (without mixture) through the copper tube, F, which leads to the heating tube, G, composed of small pieces of refractory material, of the form indicated in the design. These are intended to divide the air into thin jets projected horizontally against the sides of the tube, which is kept hot by the auxiliary burners already described. The air thus arrives at the burner at a temperature of about 1,000° C., and mixes through a perforated rose with the gas, which is brought in the shape of a horizontal sheet by means of the cap, I. Below this cap there is suspended, by platinum wires, the basket of magnesia thread already described. The combustion which goes on inside this cap is very intense, and raises the magnesia to a brilliant white heat. Lastly, the sheath of copper, L, perforated above and below with holes to admit of lighting and the discharge of the products of combustion, concentrates the heat within the burner, and thus assures a sort of regeneration. For such a burner as the one illustrated, which gives an illuminating power of 4·15 Carcels, or 39·425 candles, the consumption of gas is 180 liters, or 6·35 cubic feet per hour, and that of air blown in under a pressure of 35 mm. is six times as much, or 1,080 liters, or 38·10 cubic feet. As already stated, the basket of magnesia will last from 40 to 60 hours.

Thus far M. Servier, has discharged his task of describing M. Clamond's invention with tolerable brevity. He has, however, somewhat overlaid his subject, possibly in consequence of his own belief in its importance. It is impossible to say, until the experiment has been tried on a sufficiently large scale, whether M. Clamond has really, as claimed by M. Servier, succeeded in making the Drummond light practicable for ordinary street and domestic lighting. It is possible to admit that the burner itself is admirably designed for its work, and successful in developing a high-power light from low-class gas, while continuing to hold that the real difficulties experienced by M. Tessie du Motay remain to be vanquished by M. Clamond. It is true, as M. Servier says, that the necessity of making and distributing an additional supply of gas was the chief cause of M. Du Motay's failure; and it is obvious that the same necessity still exists in M. Clamond's system, only in a modified shape. Air is, to all intents and purposes, an extra gas; and, except in respect of first cost, is as troublesome and expensive to distribute as oxygen. M. Servier moreover points out that M. Du Motay's oxygen services and mains needed to be larger than those which supplied the gas; but surely this disadvantage is greater with air, which on the present system is to be supplied with the gas in the ratio of 6 to 1. It is difficult to perceive how the work of distribution under these conditions is to be easier on M. Clamond's system than on M. Du Motay's. We are, in fact, disposed to regard the admitted necessity of an additional air supply as constituting an insurmountable obstacle in the way of the general use of M. Clamond's or any similar burner. M. Servier argues that gas engineers in particular ought not to raise objections to the use of special mains and services, because they already have to make use of the same means of distribution in their ordinary business. We venture to say that this is precisely the reason why gas engineers will be disposed to regard with aversion the demand now made for another set of distributing plant six times as large as that already laid down for the supply of gas. Only gas engineers really know what would be involved in this additional service. It is at least certain that, so far from the air supply costing nothing, it would represent, by the time it reached the consumer's burner, a very tangible charge per 1,000 cubic feet for interest on capital outlay, repairs, and working expenses. Air, as M. Servier remarks, is free to all the world; but only so long as it is taken *au naturel*. Directly it is required to be compressed or transported, or, in short, to have work done upon it in any way, it becomes a manufactured article, and must be paid for accordingly. Hence the choice between extra supplies of air or oxygen, to be distributed and used in connection with the existing supply of coal gas, is nothing more than a choice of evils, and a matter depending upon considerations of comparative cost.

The whole question is merely one of expense, and as such is capable of easy expression. Supposing, for example, that a consumer wants, at any point, the illuminating power of about 40 candles. Dismissing for the moment all other luminants besides gas, it has to be seen how cheaply and effectually this demand may be supplied. In the first place, there are several ways open to obtain the result by gas alone. The consumer may use ordinary flat-flame burners, when he will require to burn, say, 14 cubic feet of gas per hour, or possibly more. At the same time the cost of the burners and fittings may be the possible minimum. A good Argand will supply the same light with a consumption of about 10 cubic feet of gas per hour, but at a positive increased cost of apparatus. Then a regenerative burner will require only about 7·5 cubic feet of gas per hour, but will cost much more than the ordinary Argand. Finally, the Clamond burner will do the work with about 6·5 cubic feet of gas, and 19·5 cubic feet of air; the burner being perhaps as costly in construction as the regenerative one, and requiring a small additional charge for magnesia baskets. Now it is evident that if the structural cost of the two last named burners is about the same, while the latter of them shows a gross saving in gas of only one cubic foot per hour, it can only compete with the other on condition that the extra 19·5 cubic feet of air, together with the cost of the magnesia wick, shall not exceed the value of the cubic foot of gas saved. Likewise, with respect to competition with the Argand, the extra air service, with the magnesia, and the higher cost of the apparatus generally, must not be more valuable than the 3·5 cubic feet of gas economized. If, as reported, there is a new multiple Argand in course of production which gives as high a duty as the average regenerator burner, and at a much lower charge for the apparatus, this line of reasoning may be materially strengthened. But confining our attention for the present to the comparison between the regenerator and the incandescent burners, both being costly appliances developing a high result, is there any possibility that the extra air service and magnesia wick will be supplied at the price of 1 cubic foot of gas per hour? To do this, omitting the cost of the wick, it would be necessary that the charge for distributing air—including pumping, repairs, and all incidental charges—should be less than one twentieth the cost of the same bulk of gas at the same place, allowing the supplying parties to realize a fair profit. If gas companies are to supply air instead of, or together with gas, they must make a profit by the business; just as water companies, whose prime commodity is frequently to be had, at its origin, for the pumping, find it necessary to make a substantial charge for its delivery.

Still, it is not M. Clamond's fault that the inexorable logic of trade is somewhat against the chance of his universal success, to the exclusion of all other inventors of gas-burners. His invention is a neat and satisfactory example of the transformation of heat into light, and will probably meet with considerable favor in some circumstances.—*Journal of Gas Lighting.*

THE EVERY-DAY FORMULARY.—THE GELATINO-BROMIDE PROCESS.

Emulsion.—A—Nitrate of silver 100 grains, distilled water 2 oz. B—Bromide of potassium 85 grains, Nelson's No. 2 gelatine 20 grains, distilled water 1½ oz., a one per cent. mixture of hydrochloric acid and water 50 minims. C—Iodide of potassium 8 grains, distilled water ½ oz. D—Hard gelatine 120 grains, water several oz. When the gelatine is thoroughly soaked, let all possible water be poured off D. A and B are now heated to about 120° Fahr., after which B is gradually added to A with constant agitation; C is then added. Heat in water bath for half an hour, and stir in D. After washing add ¾ oz. alcohol.

Pyro. Developer.—No. 1—Strong liquid ammonia 1 oz., bromide potassium 160 grains, water 80 oz. No. 2—Pyrogallic acid 30 grains, water 10 oz. In case of an ordinary exposure, mix equal volumes of the solutions.

Iron Developer.—Potassium oxalate solution (1 and 4) 80 parts, ferrous sulphate solution (1 and 4) 20 parts, distilled water 20 parts. To every 4 oz. of the mixed developer add from 5 to 30 drops of a ten per cent. solution of potassium bromide, and 30 drops of a solution of sodium hyposulphite (1 and 200).

Substratum or Preliminary Preparation.—Soluble silicate of soda 1 part, white of egg 5 parts, water 60 parts. After beating let it settle and filter.

Cowell's Clearing Solution.—Alum 2 parts, citric acid 1 part, water 10 parts. Edwards adds enough of a strong solution of perchloride of iron to give the preparation the color of sherry.

Eder's Method of Intensification.—The negative is first whitened by being soaked in the usual saturated solution of mercuric chloride, and, after a thorough rinsing, it is immersed in the following: Potassium cyanide 10 parts, potassium iodide 5 parts, mercuric chloride 5 parts, water 2,000 parts.

THE WET COLLODION PROCESS.

Cleaning Preparation for New Plates.—Alcohol 4 oz., jeweler's rouge ¼ oz., liquid ammonia ½ oz.

Film removing Pickle for Old Plates.—Water 1 pint, sulphuric acid 4 fluid oz., bichromate of potassium 4 oz.

Substratum.—The whites of 2 eggs are well beaten up with 6 pints of water, and 1 dr. of liquid ammonia is added.

Negative Collodion for Iron Development.—Alcohol 1 pint, pyroxyline of suitable quality 250 grains, shake well and add ether 2 pints. *Iodize this by mixing with* one-third of its volume of following: Alcohol ½ pint, iodide of ammonium 80 grains, iodide of cadmium 80 grains, bromide of ammonium 40 grains.

The Nitrate Bath.—Water 14 oz., nitrate of silver 1 oz., nitric acid one drop. Before using the bath coat a very small plate, and allow it to remain in the bath for about twenty minutes.

Normal Iron Developer.—Water 10 oz., proto-sulphate of iron ½ oz., glacial acetic acid ½ oz., alcohol ¾ oz. The amount of proto-sulphate of iron may be diminished to ¼ oz., when it is desired to obtain full contrasts, or may be increased to 1 oz., when contrasts are likely to be unduly marked.

Intensifying Solution, or Redeveloper.—Water 6 oz., citric acid 75 grains, pyrogallic acid 30 grains. When used, add a few drops of the silver bath solution to each ounce.

Eder's Lead Intensification.—After the negative has been well washed it is immersed in distilled water 100 parts, red prussiate of potash 6 parts, and nitrate of lead 4 parts. When the negative has acquired a yellowish white appearance it is again well washed and immersed in liquid sulphide of ammonium 1 part, water 4 parts.

Cyanide Fixing Solution.—Potassium cyanide 200 grains, water 10 oz.

Varnish.—Shellac 2 oz., sandarac 2 oz., Canada balsam 1 dr., oil of lavender 1 oz., alcohol 16 oz.

PRINTING PROCESSES.

Albumen Mixture for Paper.—White of egg 18 oz., add 500 grs. ammonium chloride dissolved in 2 oz. of water. Beat into a froth, allow the mixture to settle, and filter.

Sensitizing Solution.—Nitrate of silver 50 grs., water 1 oz., sodium carbonate ½ gr.

Acetate Toning Bath.—Chloride of gold 1 gr., acetate of soda 20 grs., water 8 oz.

Lime Toning Bath.—Chloride of gold 1 gr., whiting 30 grs., boiling water 8 oz., saturated solution of chloride of lime 1 drop. Filter when cold.

Bicarbonate Toning Bath.—Chloride of gold 1 gr., bicarbonate of soda 3 grs., water 8 oz.

Fixing Bath.—Sodium hyposulphite 4 oz., water 1 pint, liquid ammonia 30 drops.

Reducing Bath for Over-Printed Proofs.—Cyanide potassium 5 grs., liquid ammonia 5 drops, water 1 pint.

Encaustic Paste.—Best white wax 1 oz., oil of turpentine 5 oz.

Sensitizing Bath for Carbon Tissue.—Bichromate of potash 1½ oz., water 30 oz., ammonia 1 dr., methylated spirit 4 oz.

Enamel Collodion.—Tough pyroxyline 120 grs., methylated alcohol 10 oz., ether 10 oz., castor oil 20 drops.

Mountant for Prints.—A freshly prepared solution of the very best white gum.

Collotypic Substratum.—Soluble glass 3 parts, white of egg 7 parts, water 10 parts.

Collotypic Sensitive Coating.—Bichromate of potash ½ oz., gelatine 2½ oz., water 22 oz.

Collotypic Etching Fluid.—Glycerine 150 parts, ammonia 50 parts, saltpeter 5 parts, water 25 parts.

VARIOUS.

Luckardt's Retouching Varnish.—Alcohol 300 parts, sandarac 50 parts, camphor 5 parts, castor oil 10 parts, Venice turpentine 5 parts.

Matte Varnish.—Sandarac 18 parts, mastic 4 parts, ether 200 parts, benzole 80 to 100 parts.

Printing on Silk.—Remove all dressing from the fabric by boiling in water containing a little potash, dry, and albumenize with ammonium chloride 2 grammes, water 250 cubic cents., and the whites of 2 eggs, all being well beaten together. A 70-grain silver bath is used, and the remaining operations are as for paper.

Cyanotype Printing.—Water 1 oz., red prussiate of potash (ferricyanide) 1 dr., ammonio-citrate of iron 1 dr. Prepare and preserve in the dark. Float the paper and dry. Fixation by mere soaking in water.—*Photo News.*

A NEW SOLAR MICROSCOPE.

MR. E. LUTZ, an optician of Paris, has constructed, under the direction and advice of Prof. Guillemare, of the Charlemagne Lyceum, a solar microscope which will prove of great service for the purposes of teaching.

The apparatus, which is shown one-third actual size in the accompanying Fig. 1, has been constructed especially for the use of pupils in primary and secondary schools.

The inventor has succeeded in rendering all the parts immovable by means of binding screws, that the professor alone can maneuver by the aid of a key similar to those used in clocks. The apparatus is provided with a hollow holder, by means of which it may be placed on a vertical stand, and which likewise serves to manipulate it conveniently. Owing to such an arrangement, the microscope can be passed from hand to hand and examined successively without trouble by all the pupils.

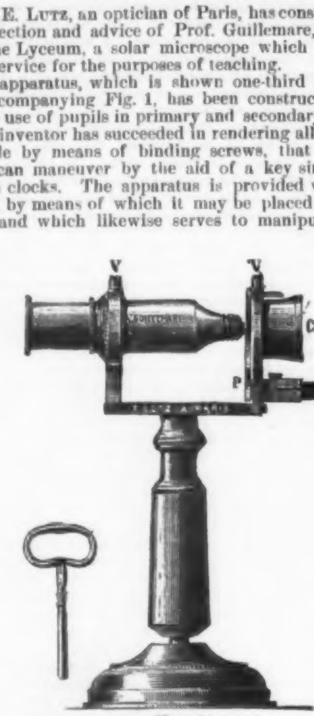


FIG. 1.

It is only necessary to direct it toward a window to have the microscopic preparation, which is held securely between brass plates, studded with points, perfectly illuminated by the rays that are concentrated upon it by a cone, *c*, of polished metal, placed in front of it.

The lenses are perfectly achromatic, and magnify 155 diameters. As a result of this, the instrument permits of the direct observation of the minutest objects, and is therefore perfectly adapted, aside from the special object for which it was designed, to scientific researches.

Mr. Lutz is also constructing, among other instruments, a new achromatic microscope, with a movement that very advantageously does away with the ordinary rack, and obviates that loss of time that necessarily occurs in manipulating the latter. This apparatus is shown in Fig. 2. Its magnifying power is at least 600 diameters.

FIG. 2.

"ON SINGING CONDENSERS."

By W. HOLTZ.

IN view of the attention which has been latterly given to the so-called singing condensers, I remark that as far back as 1875 (*Annalen*, 1875, p. 496), I made mention of a similar phenomenon, which, however, remained unnoticed. I observed it in hollow metallic disks, which I used as the electrodes of an influence machine, on bringing them so near that sparks struck across between them. I remarked then that on gradual approximation the tone did not become continually higher, but occasionally ceased entirely, because the dimension of the disk could not correspond to every height of tone, and that this is the best proof that the sound in question is not merely the sound of discharges, which may be also proved by transferring the latter to a distance. Whoever wishes to repeat the experiment, for which a single disk suffices, placed opposite a large globe, will proceed most correctly, in order to vary the approximation and the length of sparks independently of each other, if he allows the sparks to strike from one discharging rod to one of the sliding cylinders of the well-known intercalatory apparatus. With a certain succession of sparks and at a certain approximation the disk sings more distinctly, but it can sing at very different heights. Generally we hear simultaneously several and indeed disharmonic tones, such as may be heard in vibrating plates. Leyden jars must be first removed.—*Wiedemann's Annalen.*

THE HARMONY AND APPLICATION OF NATURAL LAWS.*

By B. T. GIRAUD.

IT may be accepted as an axiom in art that what is beautiful in form is substantially correct in construction. A subtle sympathy seems to exist between the purpose for which a structure is designed and the materials of which it should be composed; at once the key-stone of its beauty and its strength, there are a few apparent exceptions to this rule in which it has been very well said the poetry and mystery of beautiful organic forms lies often hid. It is this sympathy which creates in the mind of a true artist a feeling of disgust for the stucco abominations of speculative builders, and causes, even to the uneducated eye, a disagreeable sensation of fear on looking at anything which is structurally incorrect. The form of an arch, for instance, which gives to a building an appearance of grace and lightness, possesses the greatest properties of strength; it is true that the latter qualifications might be possessed by a horizontal beam of iron; but it would be at the sacrifice of truth and beauty, unless it outwardly declared the character of the material, and its falsehood would not be concealed by a miserable coat of paint. The mathematical regularity of the parabolic curve is the basis upon which the strongest engineering works have been erected; and this curve, which is the beautiful outline of a conic section, is that which is traversed by the projectile, and followed with undeviating accuracy by the jet of water. In the modern use of iron, it has enabled the engineer to calculate with the greatest precision, and without waste of material or falsely-exerted power, the proportions of those gigantic structures crossing some of the widest rivers in the world; and it is, as it were, the natural route by which the strain brought upon the structure is transmitted to its supports. When several streams of water are collected and confined, it may be from many natural escapements, the engineer knows he is dealing with a power like that of Frankenstein—that, having created or concentrated this force, he must properly employ its proclivities, or it will retaliate through its own natural laws upon its creator. The simple law of capillary attraction was the cause of the dreadful Sheffield inundation that destroyed so much life and property, and wrecked a whole valley. The water increasing in its force, crept slowly round the outer surface of the outlet pipe, until the dam through which it passed was no longer able to resist its pressure. This was the simple history of the great Sheffield disaster; but how much of great disasters, moral and physical, arises from the neglect of the rudimentary laws which govern our existence no history can ever tell us.

Let us take as another illustration, and as a special question of the day, the natural purification of water. If it is true that rivers are the natural conduits for the water supply of towns, the water of a river will be purified in its flow by the process of aeration for our use, and a portion of the rainfall by natural filtration through the soil, will come forth again in the form of springs, or be reached by the means of wells clear and limpid for our use. Can we expect that the laws of nature will be perverted for our sake, if we empty a deadly, and to a great extent, indiscernible poison into our rivers, or allow it to percolate through the earth to the purer waters of our springs? It is a folly in a country like England, where our rivers are as but streams in comparison to those of other countries, to put a burden upon them too great for them to bear, or to suppose we can remedy by mechanical filtration the inevitable evils of such a course.

The lecturer then passed to the necessity of the use of careful deduction in the investigation of natural phenomena as preferable to the use of the inverse process induction, and gave various illustrations and opinions on natural phenomena and laws. Speaking of the application of natural laws to works of art, he said: "The first consideration in the application of natural laws to works of art, it need scarcely be repeated, should be the purpose to which they are to be applied. It is not enough that houses and churches, and works of art in general, should simply be composed of stone, or brick, or wood; each having some human mission to fulfill should have its voice to speak, and having this, should be made to speak the truth, care being taken, above all things, that it does faithfully exercise those duties it outwardly professes to perform; even the surface ornamentation of a building need never be destructive to this result. The free use of natural materials, the introduction of colored bricks which may be made to diversify what is often the too uniform surface of a building, are favorable signs of our times. It must be often observed how beautifully nature subdues and tones structures; age softens the outlines of our work, and paints with various shades of fungi and with mosses the monotonous coloring of our grandest buildings.

"The various mineral compounds of the earth render the materials of construction more beautiful for our use, breaking up even the uniform surface of marbles with veins of color, with delicately graduated tint and shadow. Here in nature's works is no concealment of her purposes, and her smallest flower has the beauty and relative proportion of the largest tree. Her component parts unite at once, or honestly decline to do so, and though she is lavish to profusion there is no necessary waste; she is at once practical and poetical. For the poetical association with physical science, the allegory, as it were, of natural laws, runs through the fabric of nature like a thread of gold, and to us who quarrel over our daily works she presents the example of the unity of ages.

"In no instance can the engineer and architect work independently of each other, except, perhaps, where the engineer is engaged in work of absolute utility." Referring to several buildings in London where the architect appears to have acted in independence of the engineer, the lecturer did not consider that the taste is wanting to judge, or the ability to execute, our work; but the power is wanting to regulate our tastes against the overwhelming influence of commercial interest; for mark where these things are wanting, I mean those things which are really embellishments. To establish in the public mind a confidence in some new company we have rods of brass, desks of mahogany, seats of Russian leather, Turkey and Persian carpets, beautiful cornices high up in some cramped and narrow lanes. The old English architects were above concealment; there was no attempt to bide the method of their work, its simplicity and beauty

* A paper lately read at a meeting of the Balloon Society of Great Britain.

ask of the spectator, even from their ruins, to witness what they were. The beautiful form of a flying buttress, however elaborately carved, performs its duties in unison with the lofty Gothic roof from which it transmits the strain. Its ornamental details are subservient to its use, like a garment clothing the human figure, without obliterating the grace of its curves, concealing the natural appearance of its strength, or destroying its physical action. The grand and lofty aisles constructed on the purest principles of mathematics, their self-supporting roofs of stone, such as that of Henry VII.'s Chapel, and that of King's College, Cambridge, call to us professors of modern art who know the false application of iron, "See, we are of stone. Each stone is shaped and fitted by the hand, and acting through a natural law. No iron key or frame, or core-rusting, decaying, and expanding and contracting holds us where we are." A part of, and equal to the outward expression of work, is that of its proportion.

All beautiful proportions, I think we must admit, follow some rule which is capable of mathematical demonstration. The Great Pyramid of Egypt is supposed by Waterton and others to represent in its geometrical proportions the creative principle. In the proportion of a tree it will be found that the sectional area of the stem is equal to that of the limbs combined; and if the stem branches into three, their total area is equal to that of the stem itself, and this extends to the smallest twig upon the topmost bough. Now, in ancient temples of Greece and Rome, embracing what is known as the four orders of architecture, the Tuscan, the Doric, the Ionic, and the Corinthian, I do not think there is a single example where the diameter at the base of the column may not be taken as the scale which regulates the proportion, height, depth, and projection of every member of the building down to the smallest and least important moulding; each member is, therefore, a proportion of another. Thousands of years have passed away; one style has crowded out another; there has been the Saxon, the Norman, the Early English, the Perpendicular, the Victorian; but the immortal proportions of the Parthenon remain constantly copied but unimproved. The proportions of the human body are supposed to have been the base upon which the broad divisional proportions of architecture have been formed, taking the trunk as one division, and the head, neck, and legs as another, the measurement of the trunk being one-third of the whole body, or, in numerals, having the proportion of 1 to 2. Now another division of the human body—viz., across the diaphragm, separates it exactly in two; this is very nearly the proportion of the Parthenon, that is, the pediment and entablature above the columns and the steps below them, together are nearly equal to the height of the columns. They bear the relation of 10 parts to 9, being the difference, it will be noticed, of an aliquot part of the whole.

From this theory the following ratios have been deduced as applicable to examples of Greek and Roman remains, commencing with the proportion (that of the Parthenon) of 10 to 9, 9 to 8, 8 to 7, 7 to 6, 6 to 5, 5 to 4, 4 to 3, 3 to 2, 2 to 1, the last which gives in its proportion the lightest, the same relatively as that of the human body. A line may be drawn below the nose in any type of beauty, with the same result to the face.

I have spoken of the proportions of mouldings. I think it will be found that the profile of every beautiful moulding will agree with some part or parts of a conic section. Let us apply the question of divisional proportion to the construction of some modern work, such as a fountain or a statue. I have dwelt on the necessity of the proper application and fitness of the members of architecture to their several uses; therefore, if I had a commission, as I trust some day I shall have, to build a statue to our respected president, I would not put him like an ancient hermit on the airy summit of a lofty column, however appropriate it might be as a president of a balloon society in his native element; but the whole design should be embraced by the area of a triangle of a height proportionate to a subdivision of its base.

The conic or gradation theory, as we may call it, has nothing new; it is practically, I am aware, disregarded by many in works of art, so are still more simple laws of nature, but it pervades the universe; the leaves of plants and trees, passing from the dark green of summer to the golden yellow of October, the trees themselves, even the sap diminishing in quantity and force the further it travels from the stem, thus bringing each leaf, or a part of every leaf, to a beautifully graduated point. These are the regular operations of Nature's laws by which her grand processions move along, and by which in this age we appear to have been brought to the verge of momentous revelations. What wonder, then, if at times, they move even the mathematician to the rhapsody of the poet, and thus bridge over the chasm which divides materialism from faith.

Passing to the art of painting and sculpture, I may remind you that the system spoken of at a late trial for libel—viz., that of gradually arriving at a result in modeling by building up the bone and muscle, and ultimately the skin in clay, was spoken of as a system peculiar and exceptional. The best figure artists, that is, artists which are not only colorists, but draughtsmen, have followed this principle. George Cruikshank was one who did so. He drew the muscles in their proper position, according to the attitude of the figure, and covered them over with their surface clothing. All who wish to draw or carve human figure to produce the effect of vitality must do this, and study carefully the relative position of the muscles in relation to the garment worn by the subject-figure; the folds of the robe, and consequently the various degrees of light and shade, are dependent on the disposition of the muscles, and not simply on the position of the wooden arm of a lay-figure.

A glance at shades, or rather tones, of color which have become fashionable in dress within the last few years must be convincing, if it did not also show itself on the walls of the Academy and Grosvenor Gallery—that some change has taken place in the application of natural laws as regulating taste in color. The commonly accepted theory of Sir David Brewster, Chevreul, and others, that the three primary colors are red, blue, and yellow, has been, in a measure, displaced by the experiments of Prof. Clerk-Maxwell, Benson, and Tyndall, although the old theory still holds its place. As regards the mixing of pigments, red, green, and blue are now claimed by the advocates of the new theory as primary colors; and it has long been known that the mixture of blue rays with yellow in the solar spectrum does not produce green, but grayish white, and that red and bluish-green make yellow. Helmholtz considers there are five primary colors, red, yellow, green, blue, and violet. There is nothing discordant in the application of any of the laws of color, as propounded by Clerk-Maxwell, to the purpose of decoration; but there appears more scope in the old theory.

In drawing toward the close of this paper, I feel (in the limited time at my command) how much I have undertaken, and how little I have performed of so wide a subject. In the early age of science Spenser thus speaks of the growth of children to men:

When neither heart nor eye
  Rose-winged delight, or fabling hope deceives;
When boyhood, with quick throb has ceased to spy
  The dubious apple in the yellow leaves;
When springing from the couch where youth reposed,
  We find but deserts in the far sought shore;
When the huge book of Fairyland lies closed,
  And those strong brazen clasps can yield no more—

Ariel has been released from material bondage, and with her has vanished some of the most beautiful fancies of the past. The childhood of the world has gone by; and if our age does leave behind it any distinctive feature, it will be in its advance in science, in the faith, not of children, but of men; and yet in many of the early writers we can almost detect the struggle of nature to manifest herself through science in the language of a child. Through the darkness of superstition which surrounded phenomena in early days, the glimmering of the day star of modern discoveries could be seen, at least the herald of approaching day.

BRITISH ASSOCIATION.—PRESIDENT'S ADDRESS.

AT the fifty-second meeting of the British Association for the Advancement of Science, commenced at Southampton, on the 23d August, Dr. C. W. Siemens, the president, delivered an address as follows:

After alluding to the death of Darwin, and the untimely decease of the hon. secretary, Prof. F. M. Balfour, who recently lost his life in an attempt to ascend the Aiguille Blanche de Peuteret, Dr. Siemens proceeded: Since the days of the first meeting of the Association in York in 1831, great changes have taken place in the means at our disposal for exchanging views, either personally or through the medium of type. The creation of the railway system has enabled congenial minds to attend frequent meetings of those special societies which have sprung into existence since the foundation of the British Association, among which I need only name here the Physical, Geographical, Meteorological, Anthropological, and Linnæan, cultivating abstract science; and the Institution of Mechanical Engineers, the Institution of Naval Architects, the Iron and Steel Institute, the Society of Telegraph Engineers and Electricians, the Gas Institute, the Sanitary Institute, and the Society of Chemical Industry, representing applied science. If we consider further the extraordinary development of scientific journalism which has taken place, it cannot surprise us when we meet with expressions of opinion to the effect that the British Association has fulfilled its mission, and should now yield its place to those special societies it has served to call into existence. On the other hand, it may be urged that the brilliant success of last year's anniversary meeting, enhanced by the comprehensive address delivered on that occasion by my distinguished predecessor in office, Sir John Lubbock, has proved, at least, that the British Association is not dead in the affections of its members, and it behooves us at this, the first ordinary gathering in the second half-century, to consider what are the strong points to rely upon for the continuance of a career of success and usefulness. If the facilities brought home to our doors of acquiring scientific information have increased, the necessities for scientific inquiry have increased in a greater ratio. The time was when science was cultivated only by the few, who looked upon its application to the arts and manufactures as almost beneath their consideration; this they were content to leave in the hands of others, who, with only commercial aims in view, did not aspire to further the objects of science for its own sake, but thought only of benefiting by its teachings. Progress could not be rapid under this condition of things because the man of pure science rarely pursued his inquiry beyond the mere enunciation of a physical or chemical principle, while the simple practitioner was at a loss how to harmonize the new knowledge with the stock of information which formed his mental capital in trade.

THEORETICAL AND APPLIED SCIENCE.

The advancement of the last fifty years has, I venture to submit, rendered theory and practice so interdependent, that an intimate union between them is a matter of absolute necessity for our future progress. Take, for instance, the art of dyeing, and we find that the discovery of new coloring matters derived from waste products, such as coal tar, completely changes its practice, and renders an intimate knowledge of the science of chemistry a matter of absolute necessity to the practitioner. In telegraphy and in the new arts of applying electricity to lighting, to the transmission of power, and to metallurgical operations, problems arise at every turn, requiring for their solution not only an intimate acquaintance with, but a positive advance upon, electrical science, as established by purely theoretical research in the laboratory.

In general engineering the mere practical art of constructing a machine so designed and proportioned as to produce mechanically the desired effect, would suffice no longer. Our increased knowledge of the nature of the mutual relations between the different forms of energy makes us see clearly what are the theoretical limits of effect; these, although beyond our absolute reach, may be looked upon as the asymptotes to be approached indefinitely by the hyperbolic course of practical progress, of which we should never lose sight. Cases arise, morever, where the introduction of new materials of construction, or the call for new effects, renders former rules wholly insufficient. In all these cases practical knowledge has to go hand in hand with advanced science in order to accomplish the desired end.

Far be it from me to think lightly of the ardent students of nature, who, in their devotion to research, do not allow their minds to travel into the regions of utilitarianism and of self-interest. These, the high priests of science, command our utmost admiration; but it is not to them that we can look for our current progress in practical science, much less can we look for it to the "rule of thumb" practitioner, who is guided by what comes nearer to instinct than to reason. It is to the man of science, who also gives attention to practical questions, and to the practitioner, who devotes part of his time to the prosecution of strictly scientific investigations, that we owe the rapid progress of the present day, both merging more and more into one class, that of pioneers in the domain of nature. It is such men that Archimedes must have desired when he refused to teach his disciples the art of constructing his powerful ballistic engines, exhorting them to give their attention to the principles involved in their construction, and that Telford, the founder of the Institution of Civil Engineers, must have had in his mind's eye, when he defined civil engineering as "the art of directing the great sources of power in nature."

These considerations may serve to show that although we see the men of both abstract and applied science group themselves in minor bodies for the better prosecution of special objects, the points of contact between the different branches of knowledge are ever multiplying, all tending to form part of a mighty tree—the tree of modern science—under whose ample shadow its cultivators will find it both profitable and pleasant to meet, at least once a year; and considering that this tree is not the growth of one country only, but spreads both its roots and branches far and wide, it appears desirable that at these yearly gatherings other nations should be more fully represented than has hitherto been the case. The subjects discussed at our meetings are without exception of general interest, but many of them bear an international character, such as the systematic collection of magnetic, astronomical, meteorological, and geodetical observations; the formation of a universal code for signaling at sea, and for distinguishing lighthouses; and especially the settlement of scientific nomenclatures and units of measurement, regarding all of which an international accord is a matter of the utmost practical importance.

As regards the measures of length and weight it is to be regretted that this country still stands aloof from the movement initiated in France toward the close of last century; but considering that in scientific work metrical measure is now almost universally adopted, and that its use has been already legalized in this country, I venture to hope that its universal adoption for commercial purposes will soon follow as a matter of course. The practical advantages of such a measure to the trade of this country would, I am convinced, be very great, for English goods, such as machinery or metal rolled to current sections, are now almost excluded from the continental market, owing to the unit measure employed in their production. The principal impediment to the adoption of the meter consists in the strange anomaly that although it is legal to use that measure in commerce, and although a copy of the standard meter is kept in the Standards' Department of the Board of Trade, it is impossible to procure legalized rods representing it, and to use a non-legalized copy of a standard in commerce is deemed fraudulent. Would it not be desirable that the British Association should endeavor to bring about the use in this country of the meter and kilogramme, and, as a preliminary step, petition the Government to be represented on the International Metrical Commission, whose admirable establishment at Sevres possesses, independently of its practical work, considerable scientific interest, as a well-found laboratory for developing methods of precise measurement?

ELECTRICAL MEASURES.

Next in importance to accurate measures of length, weight, and time, stand, for the purposes of modern science, those of electricity. The remarkably clear lines separating conductors from non-conductors of electricity, and magnetic from non-magnetic substances, enable us to measure electrical quantities and effects with almost mathematical precision; and although the ultimate nature of this, the youngest scientifically investigated form of energy, is yet wrapped in mystery, its laws are the most clearly established, and its measuring instruments (galvanometers, electrometers, and magnetometers) are among the most accurate in physical science. Nor could any branch of science or industry be named in which electrical phenomena do not occur to exercise their direct and important influence. If, then, electricity stands foremost among the exact sciences, it follows that its unit measures should be determined with the utmost accuracy. Yet, twenty years ago, very little advance had been made toward the adoption of a rational system. Ohm had, it is true, given us the fixed relations existing between electromotive force, resistance and quantity of current; Joule had established the dynamical equivalent of heat and electricity; and Gauss and Weber had proposed their elaborate system of absolute magnetic measurement. But these invaluable researches appeared only as isolated efforts, when, in 1862, the Electric Unit Committee was appointed by the British Association, at the instance of Sir William Thomson; and it is to the long-continued activity of this committee that the world is indebted for a consistent and practical system of measurement, which, after being modified in details, received universal sanction last year by the International Electrical Congress assembled at Paris. At that congress, which was attended officially by the leading physicists of all civilized countries, the attempt was successfully made to bring about a union between the statical system of measurement that had been followed in Germany and some other countries, and the magnetic, or dynamical, system developed by the British Association, also, between the geometrical measure of resistance, the (Werner) Siemens unit, that had been generally adopted abroad, and the British Association unit intended as a multiple of Weber's absolute unit, though not entirely fulfilling that condition. The congress, while adopting the absolute system of the British Association, referred the final determination of the unit measure of resistance to an International Committee, to be appointed by the representatives of the several governments; they decided to retain the mercury standard for reproduction and comparison, by which means the advantages of both systems are happily combined, and much valuable labor is utilized; only, instead of expressing electrical quantities directly in absolute measure, the congress has embodied a consistent system, based on the ohm, in which the units are of a value convenient for practical measurements. In this, which we must hereafter know as the "practical system," as distinguished from the "absolute system," the units are named after leading physicists, the ohm, ampère, volt, coulomb, and farad.

I would venture to suggest that two further units might, with advantage, be added to the system decided on by the International Congress at Paris. The first of these is the unit of magnetic quantity or pole. It is of much importance, and few will regard otherwise than with satisfaction the suggestion of Clausius that the unit should be called a "weber," thus retaining a name most closely connected with electrical measurements, and only omitted by the congress in order to avoid the risk of confusion in the magnitude of the unit current with which his name had been formerly associated.

The other unit I should suggest adding to the list is that of power. The power conveyed by a current of an ampère through the difference of potential of a volt is the unit consistent with the practical system. It might be appropriately called a watt, in honor of that master-mind in mechanical science, James Watt. He it was who first had a clear physical conception of power, and gave a rational method of measuring it. A watt, then, expresses the rate of an ampère

multiplied by a volt, while a horse-power is 746 watts, and a cheval de vapeur 735.

The system of electro-magnetic units would then be:

		C.G.S. units.
(1) Weber,	the unit of magnetic quantity	$= 10^8$
(2) Ohm,	" " resistance	$= 10^9$
(3) Volt,	" " electromotive force	$= 10^8$
(4) Ampère,	" " current	$= 10^{-1}$
(5) Coulomb,	" " quantity	$= 10^{-1}$
(6) Watt,	" " power	$= 10^7$
(7) Farad,	" " capacity	$= 10^{-9}$

The word energy was first used by Young in a scientific sense, and represents a conception of recent date, being the outcome of the labors of Carnot, Mayer, Joule, Grove, Clausius, Clerk-Maxwell, Thomson, Stokes, Helmholtz, Macquorn-Rankine, and other laborers, who have accomplished for the science regarding the forces in nature what we owe to Lavoisier, Dalton, Berzelius, Liebig, and others, as regards chemistry. In this short word energy we find all the efforts in nature, including electricity, heat, light, chemical action, and dynamics, equally represented, forming, to use Dr. Tyndall's apt expression, so many "modes of motion." It will readily be conceived that when we have established a fixed numerical relation between these different modes of motion, we know beforehand what is the utmost result we can possibly attain in converting one form of energy into another, and to what extent our apparatus for effecting the conversion falls short of realizing it. The difference between ultimate theoretical effect and that actually obtained is commonly called loss; but, considering that energy is indestructible, represents really secondary effect, which we obtain without desiring it. Thus friction in the working parts of a machine represents a loss of mechanical effect, but is a gain of heat, and in like manner the loss sustained in transferring electrical energy from one point to another is accounted for by heat generated in the conductor. It sometimes suits our purpose to augment the transformation of electrical into heat energy at certain points of the circuit when the heat rays become visible, and we have the incandescence electric light. In effecting a complete severance of the conductor for a short distance, after the current has been established, a very great local resistance is occasioned, giving rise to the electric arc, the highest development of heat ever attained. Vibration is another form of lost energy in mechanism; but who would call it a loss if it proceeded from the violin of a Joachim or a Norman-Neruda?

THE TRANSMISSION OF ENERGY.

Electricity is the form of energy best suited for transmitting an effect from one place to another; the electric current passes through certain substances—the metals—with a velocity limited only by the retarding influence caused by electric charge of the surrounding dielectric, but approaching, probably, under favorable conditions that of radiant heat and light, or 300,000 kilometers per second; it refuses, however, to pass through oxidized substances, glass, gums, or through gases, except when in a highly rarefied condition. It is easy, therefore, to confine the electric current within bounds, and to direct it through narrow channels of extraordinary length. The conducting wire of an Atlantic cable is such a narrow channel; it consists of a copper wire, or strand of wires, 5 mm. in diameter, by nearly 5,000 kilometers in length, confined electrically by a coating of gutta-percha about 4 mm. in thickness. The electricity from a small galvanic battery passing into this channel prefers the long journey to America in the good conductor, and back through the earth, to the shorter journey across the 4 mm. in thickness of insulating material. By an improved arrangement the alternating currents employed to work long submarine cables do not actually complete the circuit, but are merged in a condenser at the receiving station after having produced their extremely slight but certain effect on the receiving instrument. So perfect is the channel and so precise the action of both the transmitting and receiving instruments employed, that two systems of electric signals may be passed simultaneously through the same cable in opposite directions, producing independent records at either end. By the application of this duplex mode of working to the Direct United States cable under the superintendence of Dr. Muirhead, its transmitting power was increased from 25 to 60 words a minute, being equivalent to about 12 currents or primary impulses per second.

The minute currents here employed are far surpassed as regards delicacy and frequency by those revealed to us by that marvel of the present day, the telephone. The electric currents caused by the vibrations of a diaphragm acted upon by the human voice, naturally vary in frequency and intensity according to the number and degree of those vibrations, and each motor current in exciting the electro-magnet forming part of the receiving instrument, deflects the iron diaphragm occupying the position of an armature to a greater or smaller extent, according to its strength. Savart found that the fundamental *la* springs from 440 complete vibrations in a second; but what must be the frequency and modulations of the motor current and of magnetic variations necessary to convey to the ear through the medium of a vibrating armature, such a complex of human voices and of musical instruments as constitutes an opera performance. And yet such performances could be distinctly heard and even enjoyed as an artistic treat by applying to the ears a pair of the double telephonic receivers at the Paris Electrical Exhibition, when connected with a pair of transmitting instruments in front of the footlights of the Grand Opera. In connection with the telephone, and with its equally remarkable adjunct, the microphone, the names of Riess, Graham Bell, Edison, and Hughes will ever be remembered.

Regarding the transmission of power to a distance, the electrical current has now entered the lists in competition with compressed air, the hydraulic accumulator, and the quick running rope as used at Schaffhausen to utilize the power of the Rhine fall. The transformation of electrical into mechanical energy can be accomplished with no further loss than is due to such incidental causes as friction and the heating of wires; these in a properly designed dynamo-electric machine do not exceed 10 per cent., as shown by Dr. John Hopkinson, and, judging from recent experiments of my own, a still nearer approach to ultimate perfection is attainable. Adhering, however, to Dr. Hopkinson's determination, for safety sake, and assuming the same percentage in reconverting the current into mechanical effect, a total loss of 19 per cent. results; to this loss must be added that through electrical resistance in the connecting line wires, which depends upon their length and conductivity, and that due to heating by friction of the working parts of the machine. Taking these as being equal to the internal losses incurred in the double process of conversion, there remains a useful effect of 100 — 38 = 62 per cent., attainable at a distance, which agrees with experimental results, although in actual practice it would not be safe at present to expect more than 50 per cent. of ultimate useful effect, to allow for all mechanical losses.

In using compressed air or water for the transmission of power the loss cannot be taken at less than 50 per cent., and as it depends upon fluid resistance it increases with distance more rapidly than in the case of electricity. Taking the loss of effect in all cases as 50 per cent., electric transmission presents the advantage that an insulated wire does the work of a pipe capable of withstanding high internal pressure, which latter must be more costly to put down and to maintain. A second metallic conductor is required, however, to complete the electrical circuit, as the conducting power of the earth alone is found unreliable for passing quantity currents, owing to the effects of polarization; but as this second conductor need not be insulated, water or gas pipes, railway metals or fencing wire, may be called into requisition for the purpose. The small space occupied by the electro-motor, its high-working speed, and the absence of waste products, render it specially available for the general distribution of power to cranes and light machinery of every description. A loss of effect of 50 per cent. does not stand in the way of such applications, for it must be remembered that a powerful central engine of best construction produces motive power with a consumption of 2 lb. of coal per horse power per hour, whereas small engines distributed over a district would consume not less than 5 lb.; we thus see that there is an advantage in favor of electric transmission as regards fuel, independently of the saving of labor and other collateral benefits.

To agriculture, electric transmission of power seems well adapted for effecting the various operations of the farm and fields from one center. Having worked such a system myself in combination with electric lighting and horticulture for upwards of two years, I can speak with confidence of its economy, and of the facility with which the work is accomplished in charge of untrained persons.

As regards the effect of the electric light upon vegetation, there is little to add to what was stated in my paper read before section A last year, and ordered to be printed with the report, except that in experimenting upon wheat, barley, oats, and other cereals sown in the open air, there is a marked difference between the growth of the plants influenced and those uninfluenced by the electric light. This was not very apparent till toward the end of February, when, with the first appearance of mild weather, the plants, under the influence of an electric lamp of 4,000 candle-power placed about five meters above the surface, developed with extreme rapidity, so that by the end of May they stood about 4 ft. high, with the ears in full bloom, when those not under its influence were under 2 ft. in height, and showed no sign of the ear.

In the electric railway first constructed by Dr. Werner Siemens, at Berlin, in 1879, electric energy was transmitted to the moving carriage or train of carriages through the two rails upon which it moved, these being sufficiently insulated from each other by being placed upon well creosoted cross sleepers. At the Paris Electrical Exhibition the current was conveyed through two separate conductors making sliding or rolling contact with the carriage, whereas in the electric railway now in course of construction in the north of Ireland (which when completed will have a length of twelve miles) a separate conductor will be provided by the side of the railway, and the return circuit completed through the rails themselves, which in that case need not be insulated; secondary batteries will be used to store the surplus energy created in running downhill, to be restored in ascending steep inclines, and for passing roadways where the separate insulated conductor is not practicable. The electric railway possesses great advantages over horse or steam power for towns, in tunnels, and in all cases where natural sources of energy, such as waterfalls, are available; but it would not be reasonable to suppose that it will in its present condition compete with steam propulsion upon ordinary railways.

Electric energy may also be employed for heating purposes, but in this case it would obviously be impossible for it to compete in point of economy with the direct combustion of fuel for the attainment of ordinary degrees of heat. Bunsen and St. Claire de Ville have taught us, however, that combustion becomes extremely sluggish when a temperature of 1,800° C. has been reached, and foreffects at temperatures exceeding that limit the electric furnace will probably find advantageous applications. Its specific advantage consists in being apparently unlimited in the degree of heat attainable, thus opening out a new field of investigation to the chemist and metallurgist. Tungsten has been melted in such a furnace, and 8 pounds of platinum have been reduced from the cold to the liquid condition in 20 minutes.

ELECTRIC LIGHTING.

The largest and most extensive application of electric energy at the present time is to lighting, but, considering how much has of late been said and written for and against this new illuminant, I shall here confine myself to a few general remarks.

Joule has shown that if an electric current is passed through a conductor the whole of the energy lost by the current is converted into heat; or, if the resistance be localized, into radiant energy, comprising heat, light, and actinic rays. Neither the low heat rays nor the ultra-violet of highest refrangibility affect the retina, and may be regarded as lost energy, the effective rays being those between the red and violet of the spectrum, which in their combination produce the effect of white light. Regarding the proportion of luminous to non-luminous rays proceeding from an electric arc or incandescent wire, we have a most valuable investigation by Dr. Tyndall, recorded in his work on "Radiant Heat." Dr. Tyndall shows that the luminous rays from a platinum wire heated to its highest point of incandescence, which may be taken at 1,700° C., formed 1-24th part of the total radiant energy emitted, and 1-10th part in the case of an arc light worked by a battery of 50 Grove's elements. In order to apply these valuable data to the case of electric lighting by means of dynamo-currents, it is necessary in the first place to determine what is the power of 50 Grove's elements of the size used by Dr. Tyndall, expressed in the practical scale of units as now established. From a few experiments lately undertaken for myself, it would appear that 50 such cells have an electromotive force of 98·5 volts, and an internal resistance of 13·5 ohms, giving a current of 7·3 ampères when the cells are short-circuited. The resistance of a regulator such as Dr. Tyndall used in his experiments may be taken at 10 ohms, the current produced in the arc would be 4 ampères (allowing one ohm for the leads), and the power consumed 160 watts; the light power of such an arc would be about 150 candles, and, comparing this with an arc of 3,308 candles produced by 1,162 watts, we find that 7·3 times the electric energy produce 22 times the amount of light measured horizontally. If, therefore, in Dr. Tyndall's arc 1-10th of the radiant energy emitted was visible as light, it follows that in a powerful arc of 3,300 candles, fully ⅓ are luminous rays. In the case of the incandescence light (say a Swan light of 20 candle power) we find in practice that 9 times as much power has to be expended as in the case of the arc light; hence, 1-27th part of the power is given out as luminous rays, as against 1-24th in Dr. Tyndall's incandescent platinum—a result sufficiently approximate, considering the wide difference of conditions under which the two are compared.

These results are not only of obvious practical value, but they seem to establish a fixed relation between current, temperature, and light produced, which may serve as a means to determine temperatures exceeding the melting point of platinum with greater accuracy than has hitherto been possible by actinometric methods in which the thickness of the luminous atmosphere must necessarily exercise a disturbing influence. It is probably owing to this circumstance that the temperature of the electric arc as well as that of the solar photosphere has frequently been greatly overestimated.

The principal argument in favor of the electric light is furnished by its immunity from products of combustion, which not only heat the lighted apartments, but substitute carbonic acid and deleterious sulphur compounds for the oxygen upon which respiration depends; the electric light is white instead of yellow, and thus enables us to see pictures, furniture, and flowers as by daylight; it supports growing plants instead of poisoning them, and by its means we can carry on photography and many other industries at night as well as during the day. The objection frequently urged against the electric light, that it depends upon the continuous motion of steam or gas engines, which are liable to accidental stoppage, has been removed by the introduction into practical use of the secondary battery; this, although not embodying a new conception, has lately been greatly improved in power and constancy by Planté, Faure, Volckmar, Sellon, and others, and promises to accomplish for electricity what the gas-holder has done for the supply of gas and the accumulator for hydraulic transmission of power.

It can no longer be a matter of reasonable doubt, therefore, that electric lighting will take its place as a public illuminant, and that even though its cost should be found greater than that of gas, it will be preferred for the lighting of drawing-rooms and dining-rooms, theaters and concert-rooms, museums, churches, warehouses, show-rooms, printing establishments and factories, and also the cabins and engine-rooms of passenger steamers. In the cheaper and more powerful form of the arc light, it has proved itself superior to any other illuminant for spreading artificial daylight over the large areas of harbors, railway stations, and the sites of public works. When placed within a holophote the electric lamp has already become a powerful auxiliary in effecting military operations both by sea and land.

The electric light may be worked by natural sources of power, such as waterfalls, the tidal wave, or the wind, and it is conceivable that these may be utilized at considerable distances by means of metallic conductors. Some five years ago I called attention to the vastness of those sources of energy, and the facility offered by electrical conduction in rendering them available for lighting and power-supply, while Sir William Thomson made this important matter the subject of his admirable address to Section A last year at York, and dealt with it in an exhaustive manner. The advantages of the electric light and of the distribution of power by electricity have lately been recognized by the British Government, who have just passed a bill through parliament to facilitate the establishment of electrical conductors in towns, subject to certain regulating clauses to protect the interests of the public and of local authorities. Assuming the cost of electric light to be practically the same as gas, the preference for one or other will in each application be decided upon grounds of relative convenience, but I venture to think that gas-lighting will hold its own as the poor man's friend.

[*To be continued.*]

ON THE CAUSE OF THE BLUE COLOR OF SAPPHIRE, LAZULITE, AND LAPIS-LAZULI; THE GREEN OF EMERALD AND THE PURPLE OF AMETHYST.

By LIEUT.-COLONEL W. A. ROSS, late R. A.

(1.) IN the year 1871, at Mussooree, in India, I attempted to obtain a blue color by dissolving pure alumina to saturation in a borax bead before the blowpipe; and, after a fortnight's work, obtained a very pale blue bead hard enough to scratch glass. But this experiment took me no further than the presumption that the blue color of *sapphire* is due only to the 98 per cent. of alumina, and not to traces of any supposed metallic oxide which it might contain.

(2.) Matters remained thus until the following year, when, being stationed at Woolwich with my battery, Professor G. G. Stokes did me the honor to witness some of my blowpipe experiments at that place, and eventually to read a paper upon the subject before the Royal Society (*Proc. Roy. Soc.*, vol. xx., p. 449). Among these experiments was one of the treatment of lime before the blowpipe in a bead of pure boric acid, which I found, besides forming transparent sphericles or balls of calcium borate, "caused immediate turbidity over the whole bead;" and this phenomenon was supposed by me at the time to be explainable by the following hyphothesis: "The turbid part would appear to be an attempted solution of the lime by the boric acid; the clear part, a complete solution of the boric acid in the borate of lime." (*Proc. Roy. Soc.*, vol. xx., p. 464.)

(3.) But I afterward found (*a*) that *freshly calcined* lime afforded no turbidity whatever to the boric acid bead, but only a transparent calcium-borate ball within the bead, which, when boiled out of the bead by water, was invariably four times the weight of the calcined lime employed to make it; and (*b*) that *hydrated* lime, on the contrary, rendered the bead completely opaque with turbidity, and then afforded a ball only three times the weight of the hydrate of calcium; the calculation based on this difference in weight coinciding remarkably closely with that of the amount of water in calcium hydrate, as determined by the calculation of the chemical combining weights.

(4.) It thus seemed impossible to doubt that the turbidity caused by the treatment of lime in boric acid before the blowpipe was due to the water contained in the lime, and not to the lime itself; and it was further remarked that, in calcining hydrated lime before the blowpipe, a strong orange-

colored flame was afforded, which ceased when the contained water was thus, in great part, eliminated.

(5.) I now found that the intense orange flame afforded by new platinum-foil rolled up and held in platinum tongs before the blowpipe, caused a precisely similar turbidity or opalescence in a boric acid bead upon which it was allowed to continuously impinge (which opalescent bead can be made to rehydrate calcined lime), and by fusing (in 1873) some ounces of crystallized boric acid, which previously afforded perfectly transparent beads, in an open platinum dish for several hours over a table blowpipe, I obtained a considerable quantity of opalized or "hydrated" boric acid, which now exhales a curious smell of resin on first heating before the blowpipe.

(6.) I also ascertained that when I dissolved pure alumina before the blowpipe in a bead of this opalized boric acid by means of the addition of a very small proportion of *hydrate* of potash, I obtained a pale blue or bluish bead with much greated rapidity and facility than by the experiment detailed in 1; but still the result was far from satisfactory.

(7.) Some years after this, having begun a series of experiments for the purpose of detecting traces of phosphoric acid in minerals by means of the color afforded to their solution in boric acid and potash by tungstic acid (confirmed by Mylius in the *Berichte der Deutschen Chemischen Gesellschaft*, for June, 1880, page 1145), I purchased some American *wavellite* in London* for the purpose of experiment, and, upon treating its powder in an opalized or hydrated boric acid bead with a little hydrate of potash before the blowpipe for the purpose of dissolving it previous to the addition of the tungstic acid, I was astonished to find my bead become purple, then blue, and finally a brilliant green color, without the addition of tungstic acid at all; and I soon found that no other phosphate besides aluminum hydrated phosphate (or *wavellite*) would thus afford colored beads.

(8.) The next operation was to carefully examine my *wavellite*, which seemed very pure, occurring in the usual pale greenish radiated crystals, without any admixture of matrix. This I effected by treating its fine powder in pure boric acid before the blowpipe; adding potassium carbonate in order to remove the phosphoric acid as potassium phosphate; boiling the bead in distilled water; cautiously adding ammonia until there was no further precipitate; filtering off the residual alumina; and finally testing both residue and filtrate separately in pure boric acid beads before the blowpipe. In this way I could detect nothing but alumina and phosphoric acid.

(9.) Although no phosporic acid has been detected, either in *sapphire* or *lapis lazuli*, still the equally blue *lazulite* is essentially an aluminum phosphate; and this very American *wavellite* possesses a greenish color without any apparent cause, unless it be the large proportion of *water* which it contains; while pure phosphoric acid is well known to be one of the most deliquescent substances in nature.†

(10.) I now completed my preparations by baking my crushed *wavellite* for several days in an oven, when it became a pale grey color. I also fused my potassium hydrate on aluminum plate before the blowpipe, because these measures seemed to *concentrate the water* the substances contained. and thus to cause the blue color to result more certainly and rapidly than with the raw material, with which a very fine green color is more generally obtained. (Some beads inclosed marked *c*; one cut by Hunt and Roskell.)‡

(11.) To sum up: the materials for the production of these pyrological colors are as follows:—

(*a.*) A bead of opalized or *hydrated* boric acid.
(*b.*) Baked pure *wavellite*, or *hydrated* aluminum phosphate.
(*c.*) Fused potassium *hydrate*, to dissolve *b* in *a* (to be added very cautiously before the blowpipe).

(12.) I showed a pure blue stone thus made, and set in a ring, to Dr. Tyndall in 1881, and a small bottleful of green stones to Sir W. Thomson at Swansea in 1880, at the British Association Meeting.

The colors thus producible by the blowpipe alone from these three colorless substances—*hydrated* aluminum phosphate, *hydrated* boric acid, and potassium *hydrate*—are, A, purple or "amethyst"; B, green; C, blue. Heintz proved that the color of *amethyst* is not due to manganese or titanic acid. The attribution of the green of emerald to a trace of chromic acid by some chemists is founded on a misapprehension, as solutions of chromium before the blowpipe are invariably pink when hot, but solution of emerald is *not*. Finally, it is obvious that when Gmelin found out the way to make artificial lapis-lazuli by synthesis of its constituents, which are colorless, he was no nearer the *cause* of color than Klaproth was when he found out the constituents of the mineral.—*Chemical News.*

* From Mr. Henson, Mineralogist, of Fleet Street.

† Since then, I have been able to prove, by means of the *assay* balance, the presence and proportion of this "chemical water" in *all* alumina and silica.

‡ A pure blue bead, made by me from the same materials, has since been sent to the Editor. W. A. R.

THE AROMA OF BEER.

THE peculiar, pleasant, and characteristic flavor of a sound and well brewed beer is generally attributed to certain volatile essences which are mainly derived from the hops, but to some extent also from the malt. With the exception of the volatile oil of hops, and perhaps some of the empyreumatic products of the malt, none of these essential oils which contribute aroma to beer have been isolated and examined. The aroma of beer is probably due in addition to a great variety of circumstances which influence the fermentation, and to the influence of time in the formation of peculiar ethers from the alcohol then produced. We know that wines and brandies acquire powerful and characteristic odors called "bouquet" simply by age, and no doubt similar changes take place in beers which are kept for any length of time, and this accords with the practical experience of all who have given any attention to the subject. But over and above all these causes which influence the aroma of beer there is the far more important one of the action of distinct organisms in the development of peculiar flavors during fermentation and the storage of beer. We know that saccharomyces cerevisiæ or ordinary yeast produces alcohol, that the lactic ferment produces lactic acid, which are both comparatively odorless; that the mycoderma aceti produces acetic acid, the butyric ferment butyric acid, and another ferment valerianic acid, and so on, all of which possess peculiar and characteristic odors. There are, however, numerous organisms in addition which are occasionally met with in beer, and which give rise to compounds possessing odors, but of which we know but little. Pasteur in his celebrated work "Etudes sur la Bière," page 214, mentions a particular ferment which developed such a powerful odor in beer that when only a few pints were under fermentation the whole atmosphere of his laboratory was impregnated with it. It is within the practical experience of every brewer that a gyle of beer occasionally and mysteriously acquires a peculiar and often unpleasant aroma, which is difficult to account for; if our knowledge were more perfect, we should probably be able to detect a distinct organism as the cause of each peculiar odor. By degrees scientific men are grappling with this difficult subject, but very much remains to be done before we shall be able to assign a true cause for the production of the great variety of aromas which are developed in a complex fluid like beer.—*Brewer's Guardian*

METHOD FOR THE RAPID DETERMINATION OF THE DENSITIES OF GASES.*

By C. CHANCEL.

IT frequently happens, in the course of various reactions, and especially during the dry distillation of organic substances, that gases are evolved, as to the nature of which it it is impossible for a chemist to pronounce without having recourse to analysis. In such cases a knowledge of the density of the gas is a valuable indication, frequently allowing of an immediate decision whether it is a definite body or

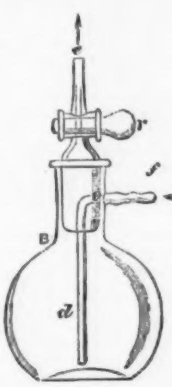


FIG. 1.

a mixture. Kopp has, in fact, shown that the molecular weight of any body, considered in a state of gas or vapor, whatever may be its composition, may be obtained by multiplying its density as compared with air by the constant 28·87, or double the quotient given by the density of air when divided by that of hydrogen (2 : 0·06926 = 28·87).

The determination of the density of gases therefore furnishes an important element of control, provided that it can be made simply and expeditiously, and at the same time with sufficient exactness.

The author proposes the following method as answering to all these requirements. A considerable experience has shown him that it is rapid and easy, and the results in respect to precision leave nothing to be desired. It is founded, like that of Dumas for vapors, upon the displacement of air from a flask by a current of the gas of which it is desired to ascertain the density.

The apparatus employed is represented in the figures. It consists of a flask (B, Fig. 1), having a capacity of 200 to 50 c.c. The neck of the flask bears a lateral tube, *f*, of small diameter, and it receives a hollow stopper, having at its upper extremity a narrow tube provided with a robinet, *r*.

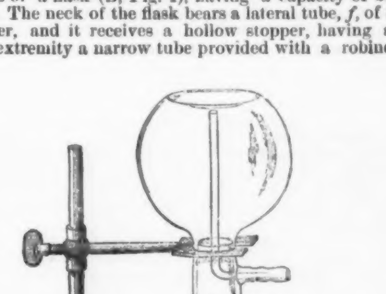


FIG. 2.

In the interior of this stopper is soldered, in the thickness of the wall, a curved tube, *d*, which reaches to within a few millimeters of the bottom of the vessel, and the upper aperture of which can be made to coincide (at *o*) with the tube, *f*, by suitably turning the stopper.

Before using this apparatus it is necessary to decide, once for all, the constants, namely, the interior volume of the flask, and the weight of a corresponding volume of air. To do this the apparatus is filled with distilled water, of which the temperature is taken, and after making sure that no bubble of air remains either in the flask or the stopper, it is weighed. The flask is then emptied, dried carefully, and the stopper and robinet are coated with a slight film of grease; it is then filled with dry air by connecting the tube in the neck, *f*, with a potash and a chloride of calcium tube, and the tube in the top of the stopper, *e*, with an aspirator. The temperature and pressure having been noted, the flask is closed and the weight accurately determined. The excess of the weight of the flask full of water over that of the flask full of air gives the apparent weight of the water, from which the internal volume, V, is easily determined.

The variations of barometric pressure and temperature, and the hygrometric state of the air exercise a notable influence upon the results. It is also necessary, in order to nullify the effects of dust, to tare the flask, not with a weight, but, as laid down by Regnault, with a compensating flask of the same external volume, and blown with the same kind of glass. This tare is definite, and will remain invariable as long as the gas flask undergoes no change. It is therefore desirable to avoid displacing unnecessarily the stopper or the robinet, so as to avoid the risk of removing a portion of the film of grease. All gas can be easily expelled from the flask by a current of dry air.

The constants being known, the density of a gas is determined as follows. After having opened the robinet, *r*, and turned the stopper so as to bring the upper aperture, *o*, of the curved tube, *d*, exactly opposite that of the tube in the side of the neck, *f*, these tubes are connected by means of caoutchouc with the current of gas. The gas, which should be previously suitably washed and carefully dried, in this way reaches the bottom of the flask, and rapidly displaces the air, which escapes by the tube, *e*, in the stopper.

In order to ascertain exactly the temperature of the gas that enters the flask, the tube, *e*, is connected with a large tube, in the axis of which is placed a very sensitive thermometer. The whole is inclosed in a wooden frame having two of its opposite sides glazed, so as to protect the flask and thermometer from sudden changes of temperature.

At the moment of concluding the operation the indications of thermometer and barometer are noted, and the stopper is turned carefully without raising it; having thus stopped the inflow of gas, the caoutchouc is removed from the tube, *f*, and the robinet is closed. Operating in this way the gas which fills the flask is placed in complete equilibrium with the external pressure.

When the gas is heavier than air the flask is placed as in Fig. 1; but with gases lighter than air the flask is fixed in a reversed position on a stand, as shown in Fig. 2.

The flask being placed in the balance, when it has taken the temperature of the frame, the weighing is effected. The data being thus obtained, the calculation for deducing the density of the gas is made as follows:

V = internal volume of the flask, in c. c.*

a = constant weight of the air corresponding to the volume V, at the temperature and under the pressure observed, which the flask contains when the tare is taken.

e = excess, positive or negative, of the weight of the flask full of gas as compared with the flask full of air.

t = temperature of the gas.

H = barometric pressure reduced to zero.

The weight, *p*, of the gas will be—

$$p = a \pm e,$$

according as the gas is heavier or lighter than air. Thus, with a flask having a capacity of 223·6 c. c., the air weight was found to be, $a = 0{\cdot}2807$ gram. Filled with carbonic acid gas the weight of the flask was augmented, $e = 0{\cdot}1445$ gram., while when filled with ammonia it lost 0·1155 gram. Accordingly the weights of the two gases are—

Carbonic acid gas, $p = 0{\cdot}2807 + 0{\cdot}1445 = 0{\cdot}4252$ gr.
Ammonia, . . $p = 0{\cdot}2807 - 0{\cdot}1155 = 0{\cdot}1652$ gr.

To obtain the density, D, of the gas it is necessary to bring to the normal temperature and pressure the volume, V, when the flask was closed at the temperature, *t*, and the pressure, H; then to multiply the volume so corrected by 0·001293 gram., which is the weight of 1 c. c. of air at 0° and 760 mm., and multiply the weight, *p*, of the gas by the product. It would then be—

$$D = \frac{p(1 + 0{\cdot}003665 \cdot t) \cdot 760}{V \cdot 0{\cdot}00129}$$

Substituting for V its value, 223·6 c.c., which is invariable as long as the same flask is used, the expression of the density becomes, after the reduction of the constants,

$$D = p(1 + 0{\cdot}003665 \cdot t) \cdot 2628 \cdot \frac{1}{H}$$

The author gives a table representing the densities of a number of gases taken by this method, which appears to show that it gives very good results. He considers it especially adapted for taking the density of gases used for lighting or escaping from the soil or in the galleries of mines, and other technical cases.—*Pharmaceutical Journal.*

* Comptes Rendus, vol. xciv., p. 626.

* As the operation is conducted at the surrounding temperature, which only varies within moderate limits, no account need be taken of the dilatation of the envelope, since it cannot change the capacity of the flask more than one-tenth of a cubic centimeter, a quantity inappreciable relative to errors of observation. The volume of the flask may therefore be considered as constant.

ABSORPTION OF METALLIC OXIDES BY PLANTS.

FROM a series of experiments by F. C. Phillips, he states that it seems safe to conclude:

1. That healthy plants grown under favorable conditions may absorb through their roots small quantities of lead, zinc, copper, and arsenic.

2. That lead and zinc may enter the tissues in this way without causing any disturbance in the growth, nutrition, and functions of the plant.

3. That the compounds of copper and arsenic exert a distinctly poisonous influence, tending, when present in larger quantity, to check the formation of roots, and either killing the plant or so far reducing its vitality as to interfere with nutrition and growth.

In the case of the heavy metals, copper, zinc, arsenic, and lead, it seems to be probable that their oxides may, under certain circumstances, become deposited in the tissues of the plant. As to the manner in which this takes place, authorities differ.

It is supposed by Freytag and others that plants absorb all soluble matters indiscriminately, through their numberless rootlets, that the absorption of poisonous metals causes no disturbance until a certain degree of concentration is reached, when the plant rapidly withers and dies; that plants are therefore spared the sufferings of chronic poisoning, but are very susceptible to acute poisoning, which is invariably fatal; while it is held by others that plants absorb only such elements as are essential and nutritious, refusing to take up what is poisonous or innutritious; metallic compounds found in the analyses are therefore to be traced to atmospheric deposit adhering externally.

The theory of Freytag seems to have the weight of facts in its favor, and if it is possible that crops may become charged in this way with poisonous elements of the soil, it becomes a matter of the highest importance that wherever there is danger of such impregnation the most efficient means be employed for its aversion; for soil once impregnated with copper, lead, and zinc, may year after year bear crops poisoned in the same manner.

BRILLIANCY AND SURFACE OF LUMINOUS POINTS.

M. CHARPENTIER has studied with great care the limits of visibility by the naked eye of extremely small luminous points. It is possible that this problem may be taken in connection with the subject of the comparative influence of bulk and intensity of a light-source in rendering it visible at a distance. At present, however, M. Charpentier's researches have been confined to the observation of small luminous points upon a black ground. Among other results, he has found that whatever may be the number and disposition of these points, in order to render them distinguishable one from another, they must be illuminated more brightly the smaller the surface of every point. The proportion is exact, and is capable of expression in the following terms: The minimum brightness is inversely proportional to the surface of the luminous point. It is evident, if this law holds good with luminous bodies of larger size than those studied by M. Charpentier (which varied from two-tenths of a millimeter to one millimeter in diameter), that the intense but minute light of the electric arc, and even of the incandescent electric lamps, is greatly affected by its small area. Precise experiments are needed to establish or refute this hypothesis.

THE RESUSCITATION OF THE DROWNED.

AT this season of the year every intelligent person—physician or layman—should be in possession of definite and easily applied information in regard to the best methods of resuscitation of the drowned. Accidents of the sort are so common, and lives are so frequently lost through neglect promptly to resort to approved remedial measures, or, still oftener, are extinguished, when trembling in the balance, by well-meant but rude and harmful endeavors at revival, that the subject becomes one of general interest and importance.

It is, of course, recognized that the primary indication in the treatment of drowning, as in all cases of apnœa, is to procure the free entrance into the air-cells of the lungs of a sufficient quantity of pure air, which shall oxygenate the poisoned blood and re-establish the obstructed pulmonary circulation. It also is beyond dispute that that method of resuscitation is to be preferred which, while applicable under any circumstances and without a moment's delay, enables the operator to expand the chest of the patient to the fullest possible extent, or, in other words, to supply with each movement of respiration the greatest amount of fresh air. In determining, therefore, the particular form of artificial respiration to be selected in such cases, we may begin by discarding all those which depend for their usefulness upon the employment of apparatus, such as bellows, tubes, etc., which are not always immediately procurable, and we are thus reduced to the utilization of various forms of passive movement of the body and limbs of the patient as the only means of attaining the desired object. This, it should always be kept in view, is full expansion of the chest.

The chief methods by which this is effected are more or less familiar, at least by name, to most persons; but it is often astonishing to find in a case of real emergency how little exact knowledge of the subject exists, and how ineffective the efforts at help are apt to be. They may be classified as mouth-to-mouth inflation, manual pressure, the Howard method, the Silvester or "physiological" method, the Marshall Hall method, and the modifications of these known as Pacini's, Bain's, and De Chilly's methods.

The first of these, in which the mouth of the operator is applied to that of the patient, and air forced directly from the lungs of the former into those of the latter, is open to the objection that the amount thus transferred depends largely upon the muscular force and chest capacity of the person supplying it, and that, even if it be sufficient in quantity, it is necessarily loaded with carbonic acid, and, therefore, not well adapted to respiratory purposes. The method of manual pressure, which consists in bearing with some force—not greater than thirty or forty pounds—upon the lower part of the breast-bone and upper and middle part of the abdomen, and then suddenly relaxing the pressure, and which is practically identical with the method known as "Howard's," has been effectual in some cases. Experiment has shown, however, that by this plan not more than twelve or fourteen cubic inches of air can be expelled and readmitted, and that consequently it is inferior to others about to be described. There is danger, too, that, in making the abdominal pressure, food may be forced from the stomach into the pharynx, and subsequently drawn into the air passages; and this accident has occurred.

The Marshall Hall method consists in turning the body on the side and a little beyond, and then briskly on the face, alternately; each time the body assumes the latter position, gentle but firm pressure being made over the shoulder-blades and the lower ribs posteriorly. The whole amount of air exchanged by this procedure has been found not to exceed fifteen cubic inches, and often to be much less. The method, as described by its author, is also objectionable for the reason that the first movement which is executed is the one of expiration, thus driving out of the lungs what little air they may contain, and losing a few seconds of time, which might be sufficient, in many instances, seriously to influence the result.

The Silvester method is worthy of more detailed description, as equally easy of application with those already mentioned, as open to none of the objections which may be urged against them, and as securing, when employed with a slight modification, an exchange of from thirty to fifty cubic inches of air with each respiratory movement. Its purpose is to imitate the action of the pectoral and other muscles passing from the chest walls to the arms and shoulders, which become inspiratory muscles during deep inspiration, and this is effected as follows, the preliminary instructions being applicable to any of the above methods of resuscitation. The patient should be turned on the face, the mouth opened, the tongue grasped with a handkerchief and drawn forward, and the hips slightly elevated. He should be held in this position four or five seconds, or even twice as long, if fluid continues to escape from the mouth or nose. He should then be turned on the back, a roll of clothing, a cushion or some similar support being placed just below the angles of the scapulæ. The tongue should still be drawn forward and retained in that position by an assistant or by a strip of muslin tied around it and beneath the chin. The operator, standing above the head of the patient, should then grasp the arms at the elbows, and draw them directly upward and outward until they nearly meet above the head, thus placing on the stretch the pectoral, latissimus, teres, etc., and elevating and rotating the ribs, or, in other words, imitating the action of forced inspiration. The arms should then be immediately turned and replaced at the side. According to the original plan, as proposed by Dr. Silvester, we believe the movement of expiration was then to be imitated by pressing the arms against the side of the chest, but there is good reason for preferring the modification suggested by the Committee of the Royal Medical and Chirurgical Society, who, at this stage, recommend that moderate pressure be made with both hands on the lower part of the breast-bone. This entire process should occupy about five seconds, so that about twelve complete respiratory movements may be made within the minute. The usual mistake in respect to time is that the movements are made too hurriedly, producing an insufficient, panting respiration. While this is being done, hot or cold water may be dashed over the chest, the limbs rubbed from below upward, ammonia held to the nostrils, and hot coffee or brandy given by enema. When respiration is now fairly established, the patient should be wrapped in blankets, kept strictly in the horizontal position, and conveyed to bed, care being taken that, while the warmth of the body is maintained, the air which is breathed shall be cool and pure.

The subsequent treatment consists simply in the cautious administration of food and stimulants, warm milk and brandy, beef-tea, coffee, etc., until strength is re-established.

The methods of Pacini and Bain are peculiar in that the chest is expanded by making traction in an upward direction with the fingers in the axillæ, the only difference between them and the plan just described being in the application of the force to the upper instead of the lower part of the arms.

De Chilly's method consists in thrusting the fingers beneath the false ribs, and alternately elevating and compressing them, in this way imparting to the general thoracic wall the movements of expansion and contraction. It offers no special advantage.

The prognosis in cases in which complete immersion has occurred for more than two minutes, and the entrance of water into the lungs and the exit of air therefrom have been unimpeded, is exceedingly unfavorable. We know of no authentic instances in which efforts at resuscitation had been successful in such a case. Those instances of recovery after long continuance in the water, of which we frequently hear, will be found on investigation to have taken place under circumstances which permitted an occasional inspiration, a momentary gasp for air which, however insufficient, permitted each time a little oxygenation to take place, and prevented the complete cessation of circulation and respiration.—*Med. News.*

THE GRAPHICAL METHOD AS APPLIED TO THE FEET.

IT is often surprising how slowly a good method of study advances. The graphical method of studying the feet was begun thirty years ago, and yet in spite of this and of the brilliant results of Marey, Ludwig, and a host of others, in the use of the same method for other purposes, it is only of late that it has been systematically applied to the investigation of the physiology and pathology of the feet.

The first to appreciate the value of the method were the medico-legal physicians. Hugoulin, as long ago as 1850, used stearin and gelatine to reproduce footprints of the criminal as a means of identification, and though not strictly graphic, yet doubtless it suggested the method which Caussé published, in 1854, in the *Annales d' Hygiène*, and which in principle, though with ingenious modifications, is to-day still the best. One footprint made evidently by a bare and bloody highly arched left foot was found, and there were eight asserted criminals. He smeared the floor with defibrinated blood. Each of the eight prisoners stepped first on the bloody floor with the bare left foot and then on to a brick. Each impression so made was measured by ordinates and abscissæ, and compared with the tell-tale footprint for identification.

In 1872, Duhousset used moist sand in studying the foot-sole of the Kabyles, and in the same year Volkmann, in Pitha and Billroth's *Handbuch*, presented figures of flat feet obtained by transferring the impression of the blackened foot-sole to paper.

But the real systematic graphic study of the feet we owe chiefly to Hilton, Onimus, and Rohmer. Two methods are practicable: the first by tracing the outlines of the foot, the other by obtaining the impression of the sole of the foot.

Hilton, in his *Rest and Pain*, in 1863, attracted especial attention to the outline method. In many cases of disease not only in the foot, but in the various portions of the lower extremity, he observed that the feet were unequally developed, and accordingly with the patient's feet on paper he drew their outlines by a pencil held vertically, and these he reproduced in many places in his admirable book. Sayre, Judson, and others have followed the method, and it is very simple, easy, and, if due care be employed, reasonably accurate.

The other method was established by Onimus in 1876, and he has published several very valuable papers since then, the most recent being in the *Revue de Medecine* for 1881, and in the *Revue de Chirurgie* for last June.

In 1879, Rohmer, in a Thesis for the Doctorate, presented to the Faculty of Nancy, carried the system even further and applied it to the physiology of this portion of the muscular system with not a little success. After dissecting the muscles from the knee nearly to the ankle, just enough to separate them one from another, but not enough to disturb their relations to the bones, sheaths, etc., he first took an impression of the foot-sole in repose; then by traction on one muscle after another, and on groups of muscles such as would be related in normal action or in disease, he was able to show what variations in the impressions of the foot-sole were produced by the muscles, either singly or in groups.

The method adopted by Onimus to obtain the impression is to smoke the paper by a wick soaked in turpentine, being careful not to burn the paper, as that would obscure the results. The patient then treads on the paper, and where the sole has touched it the paper is bared of lamp-black. The impression is then rendered permanent by a fixative applied by an atomizer. Rohmer uses copal varnish; Onimus, "fusian" varnish. We would suggest that collodion and ether would be equally effective and much quicker in drying. Shellac and alcohol also may be used. One point is not to be forgotten, that the figures either of the outlines or the impressions should be reproductions of the figures on the paper and not of the foot-soles themselves, for in the latter case the right and left feet would be reversed to the reader.

The method has been already fruitful in results. Not only has the physiology of the muscles of the leg and foot been elaborated, and to some extent corrected, but paralysis, contractures, arthritis of the ankle and of the different joints of the foot, contusions, and other injuries, have all been shown to affect the forms of the feet very appreciably, though the disease be at a distance, and sometimes of cerebral origin.

Three types of foot imprint exist. First, the arched foot, consisting of three distinct imprints, the heel, the cushion under the heads of the metatarsal bones, or "anterior heel," as Duchenne has aptly called it, and the toe-tips. Secondly, the flat-foot, in which the entire sole touches the ground, and thirdly, an intermediate, commonest, and best form in which the imprints of the heel and of the metatarsal pad are connected along the outer border of the foot by a narrower or wider line or band. Any one on getting out of a bath and stepping on to dry paper, or a bare floor, can try the method extemporaneously and see to which of the three types his foot belongs.

Possibly also the cutaneous markings on the sole might be studied with advantage. The Chinese, it is asserted, have a "Rogues' Gallery" of the thumb imprints of their criminals. It might be equally valuable to reproduce their foot-soles in a similar way.—*Med. News.*

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